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Intellectual Property Administration
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PATENT APPLICATION

ATTORNEY DOCKET NO. 10010538-1

IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Xiao-An Zhang et al.

Confirmation No.: 1230

Application No.: 09/823,195

Examiner: EVERHART, C.M.

Filing Date: March 29, 2001

Group Art Unit: 2891

Title: Bistable molecular mechanical devices with a band gap change activated by an electric field for electronic switching, gating, and memory applications

Mail Stop Appeal Brief-Patents
Commissioner For Patents
PO Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF APPEAL BRIEF

Transmitted herewith is the Appeal Brief in this application with respect to the Notice of Appeal filed on May 22,2008.

The fee for filing this Appeal Brief is (37 CFR 1.17(c)) $500.00.

(complete (a) or (b) as applicable)

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136(a) apply.

☐ (a) Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d)) for the total number of months checked below:

☐ 1st Month $120 ☐ 2nd Month $450 ☐ 3rd Month $1020 ☐ 4th Month $1590

☐ The extension fee has already been filed in this application.

☒ (b) Applicant believes that no extension of time is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

Please charge to Deposit Account 08-2025 the sum of $ 500. At any time during the pendency of this application, please charge any fees required or credit any over payment to Deposit Account 08-2025 pursuant to 37 CFR 1.25. Additionally please charge any fees to Deposit Account 08-2025 under 37 CFR 1.16 through 1.21 inclusive, and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees.

☒ A duplicate copy of this transmittal letter is enclosed.

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Typed Name: Joanne Bourguignon

Signature: Joanne Bourguignon

Respectfully submitted,

Xiao-An Zhang ~~et~~ al.

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Reg No.: 54,614

Date: August 19, 2008

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Rev 10/06a (AplBrief)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

In re Application of: XIAO-AN ZHANG ET AL Confirmation No.: 1230

Serial No.: 09/823,195 Group Art Unit: 2891

Filed: March 29, 2001 Examiner: C. M. Everhart

For: BISTABLE MOLECULAR MECHANICAL DEVICES WITH A BAND GAP CHANGE ACTIVATED BY AN ELECTRIC FIELD FOR ELECTRONIC SWITCHING, GATING, AND MEMORY APPLICATIONS

Docket No. : 10010538-1

Date : August 19, 2008

APPEAL BRIEF

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Alexandria, VA 22313-1450

Sir:

This appeal is from the decision of the Examiner, in an Office Action mailed February 22, 2008, finally rejecting claims 1-3, 20-23, and 40 and objecting to claims 4-19 and 24-39.

REAL PARTY IN INTEREST

The real party in interest is Hewlett-Packard Development Company, LP, a limited partnership established under the laws of the State of Texas and having a principal place of business at 20555 S.H. 249 Houston, TX 77070, U.S.A. (hereinafter "HPDC"). HPDC is a Texas limited partnership and is a wholly-owned affiliate of Hewlett-Packard Company, a Delaware Corporation, headquartered in Palo Alto, CA. The general or managing partner of HPDC is HPQ Holdings, LLC.

RELATED APPEALS AND INTERFERENCES

Applicant's representative has not identified, and does not know of, any other appeals of interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

STATUS OF CLAIMS

Claims 1-3, 20-23, and 40 and objected claims 4-19 and 24-39 are pending in the application. Claims 1-3, 20-23, and 40 and objected claims 4-19 and 24-39 are pending in the application and were finally rejected in the Office Action dated February 22, 2008. Applicants' appeal the final rejection of claims 1-3, 20-23, and 40 and objected claims 4-19 and 24-39 which are copied in the attached CLAIMS APPENDIX.

STATUS OF AMENDMENTS

No Amendment After Final is enclosed with this brief. The last Amendment was filed November 20, 2007.

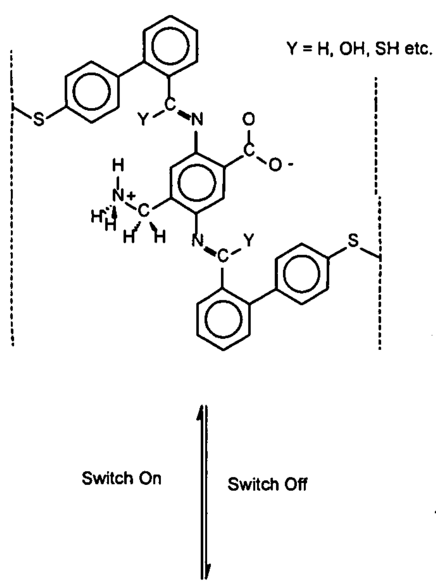
SUMMARY OF CLAIMED SUBJECT MATTER

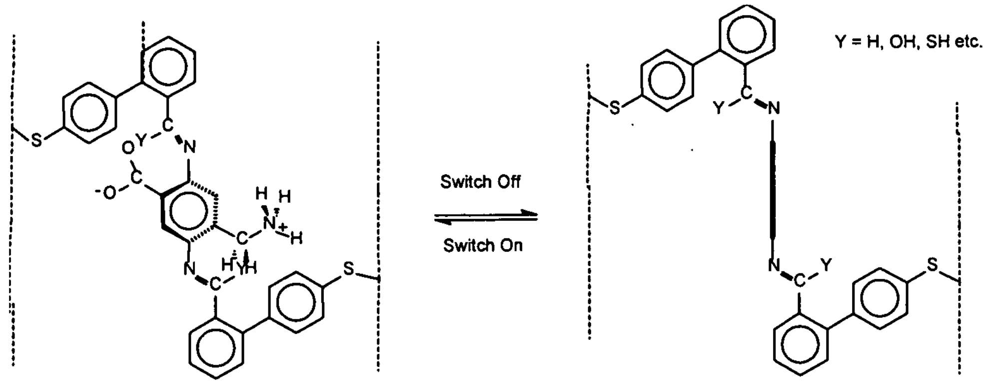
Independent Claim 1

Claim 1 is directed to an electric field activated molecular switch comprising a molecular system that has an electric field induced non-redox type of band gap change (Current Application page 14, lines 13-14) resulting from an intramolecular change in conjugation as p,π-electrons of the molecular system, through its highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), are alternately localized and delocalized over the entire molecular system by an applied electric field, wherein said electric field induced band gap change occurs via one of the following mechanisms: (1) molecular conformation change or an isomerization (Current Application page 14, lines 7-8; page 15, lines 8-15, Figure 2); (2) change of extended conjugation via chemical bonding change to change the band gap (Current Application page 14, lines 9-10; page 21, lines 22-29, Figure 3a; page 24, line 28 to page 25, line 5, Figures 3b); or (3) molecular folding or stretching (Current Application page 14, lines 11-12; page 31, lines 9-18, Figure 4).

<u>Dependent Claims 2-20</u>

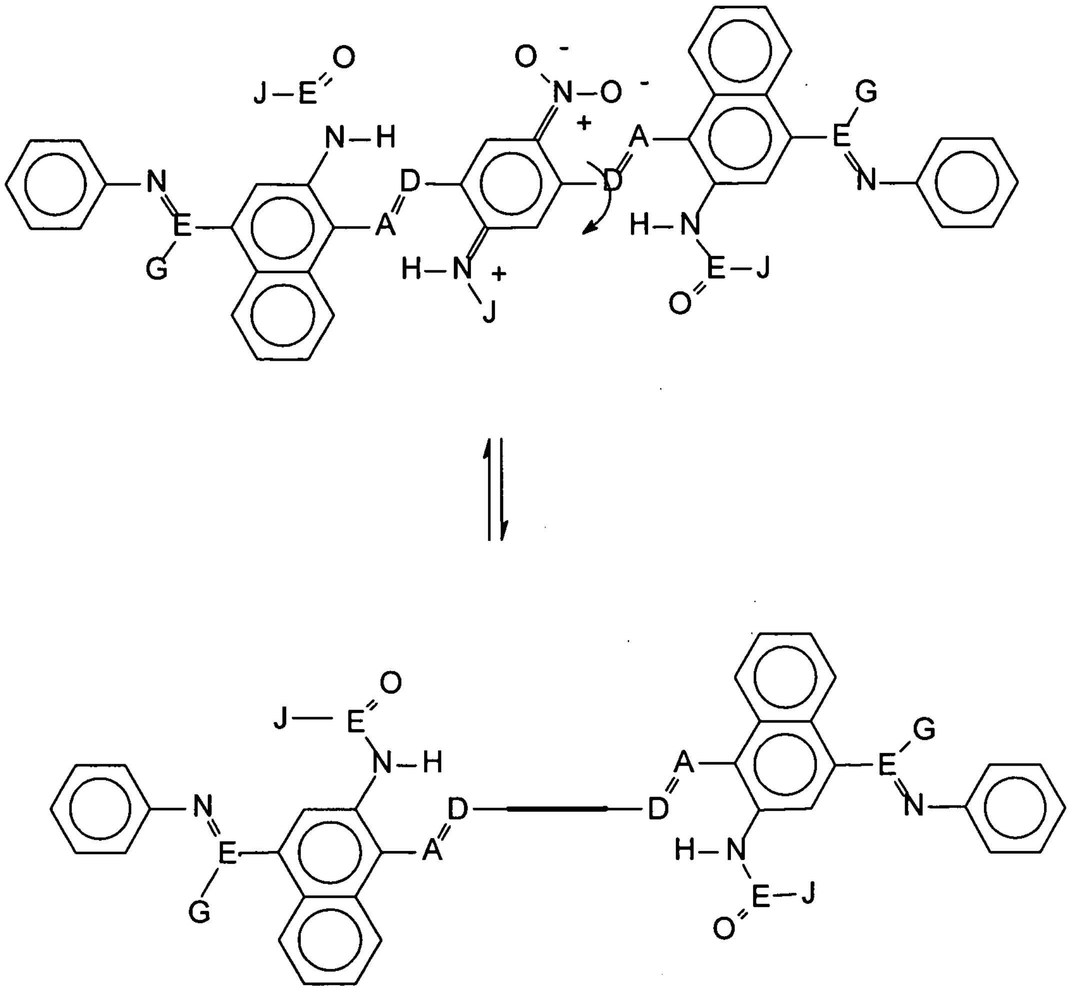
Claim 2 is directed to the molecular switch of claim 1 wherein said electric field induced band gap change occurs via molecular conformation change or an isomerization (Current Application page 16, lines 10-11). Claim 3 is directed to the molecular switch of claim 2 wherein said molecular system comprises at least one stator portion and at least one rotor portion, wherein said rotor rotates from a first state to a second state with an applied electric field, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap (Current Application page 16, line 10 to page 17, line 12). Claim 4 is directed to the molecular switch of claim 3 wherein said molecular system comprises:





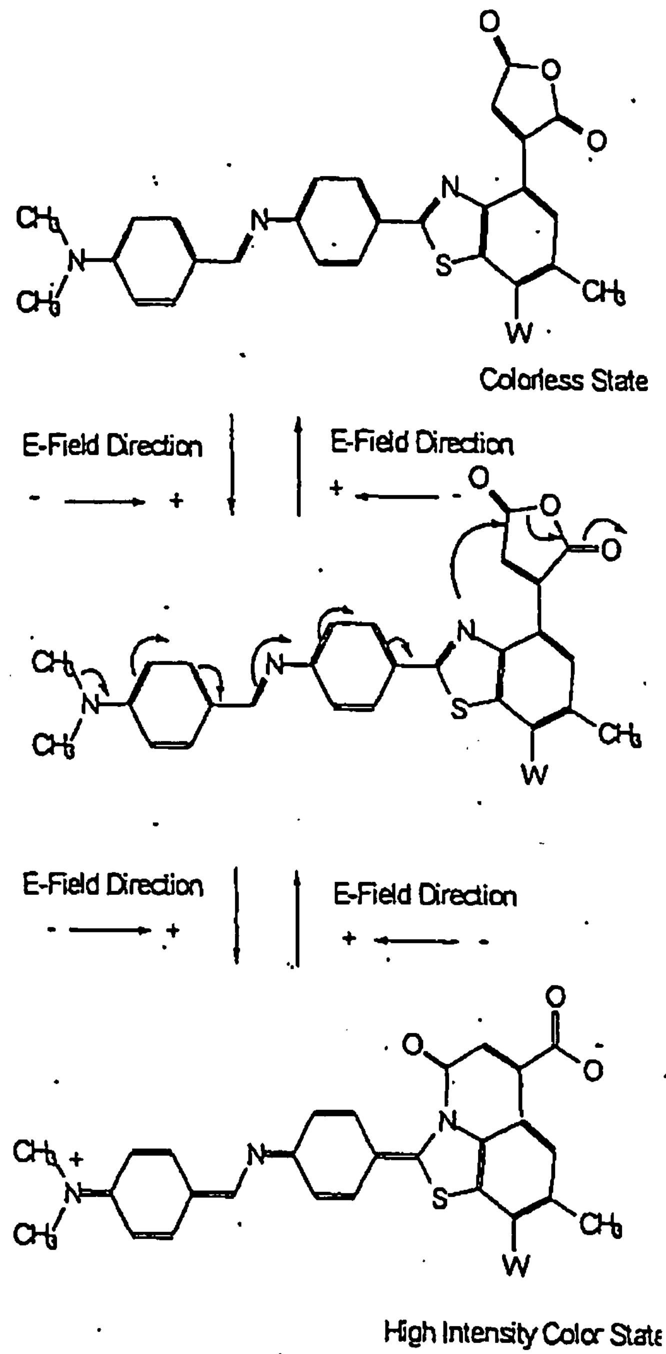
where the vertical dashed lines represent electrodes to which said molecule is electrically attached (Current Application page 17, line 13 to page 19, line 13).

Claim 5 is directed to the molecular switch of claim 3 wherein said molecular system comprises:

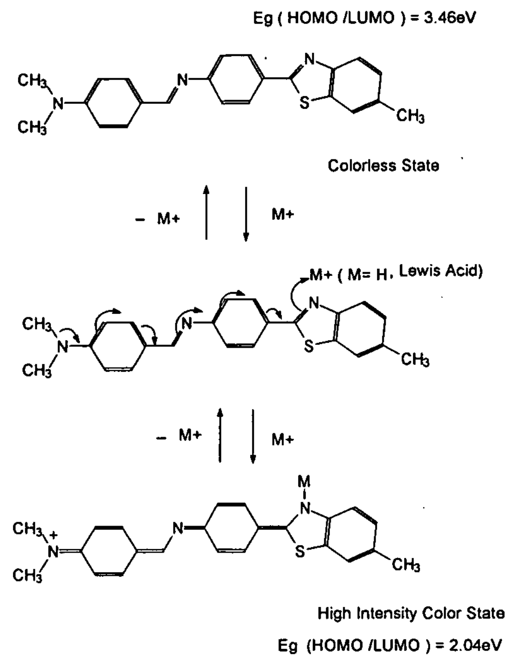


wherein the letters A, D, E, G, and J indicate sites where different chemical units can be utilized to adjust geometrical structure and optical properties of said molecular system and have generic designations as follows: A, D, E, G, and J are independently selected from the group consisting of heteroatoms, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom, and where in addition to the foregoing, the letters G and J are independently selected from the group consisting of hydrogen, F, Cl, Br, and I (Current Application page 19, line 20 to page 21, line 5). Claim 6 is directed to the molecular switch of claim 1 wherein said electric field induced band gap occurs via a change of extended conjugation via chemical bonding change to change the band gap (Current Application page 21, lines 19-21). Claim 7 is directed to the molecular switch of claim 6

wherein said electric field induced band gap change occurs via a change of extended conjugation via charge separation or recombination accompanied by increasing or decreasing band localization (Current Application page 21, lines 22-25). Claim 8 is directed to the molecular switch of claim 7 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, thereby resulting in a relatively larger band gap state, with less π-delocalization, and recombination of charge in changing from said second state to said first state, thereby resulting in a relatively smaller band gap state, with greater π-delocalization (Current Application page 21, lines 25-29). Claim 9 is directed to the molecular switch of claim 8 wherein said molecular system comprises (Current Application page 22, line 23, to page 23, line 24):

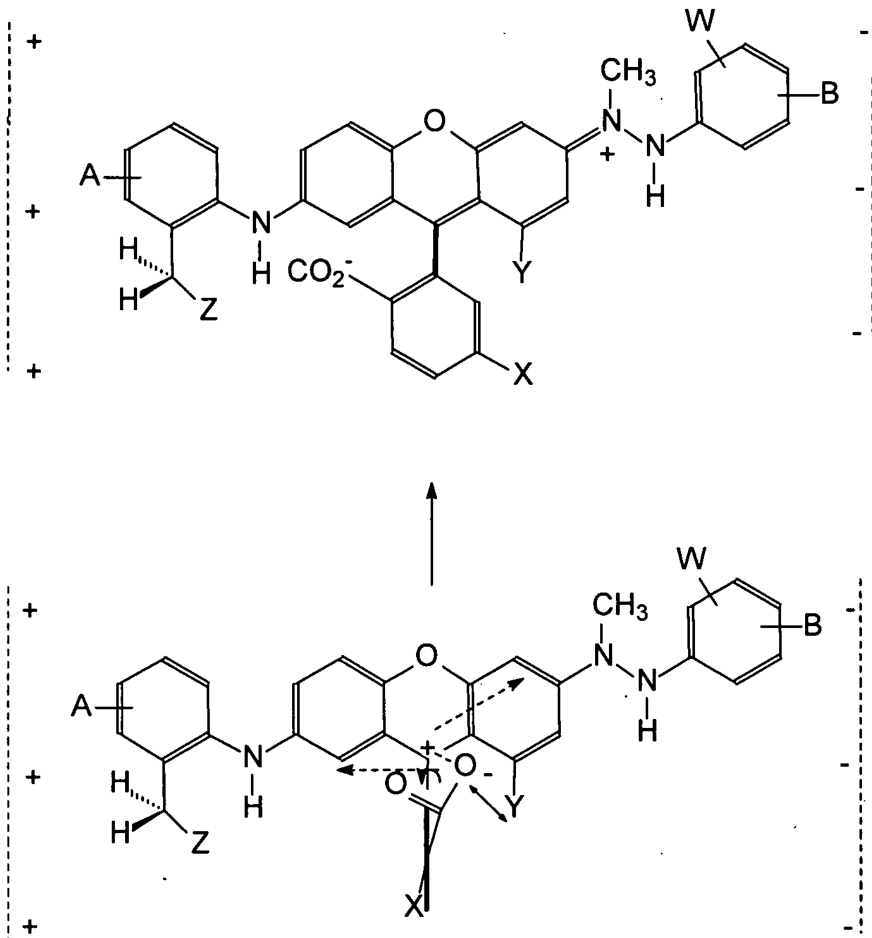

O
O
O
N
CH3
N
N
CH3
S
CH3
W
Colorless State
E-Field Direction
- +
E-Field Direction
+ -
E-Field Direction
- +
E-Field Direction
+ -
O
O
O
N
N
N
S
W
CH3
O
O
O
N
S
W
CH3
+
High Intensity Color State

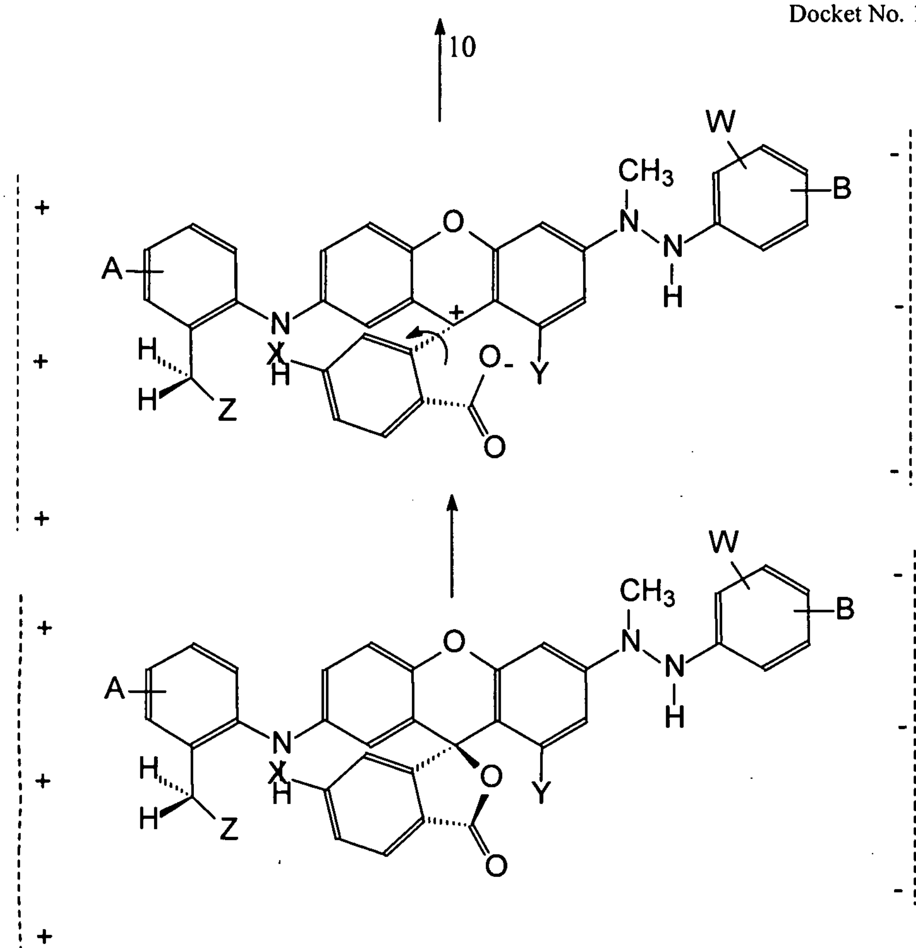
Claim 10 is directed to the molecular switch of claim 8 wherein said molecular system comprises:



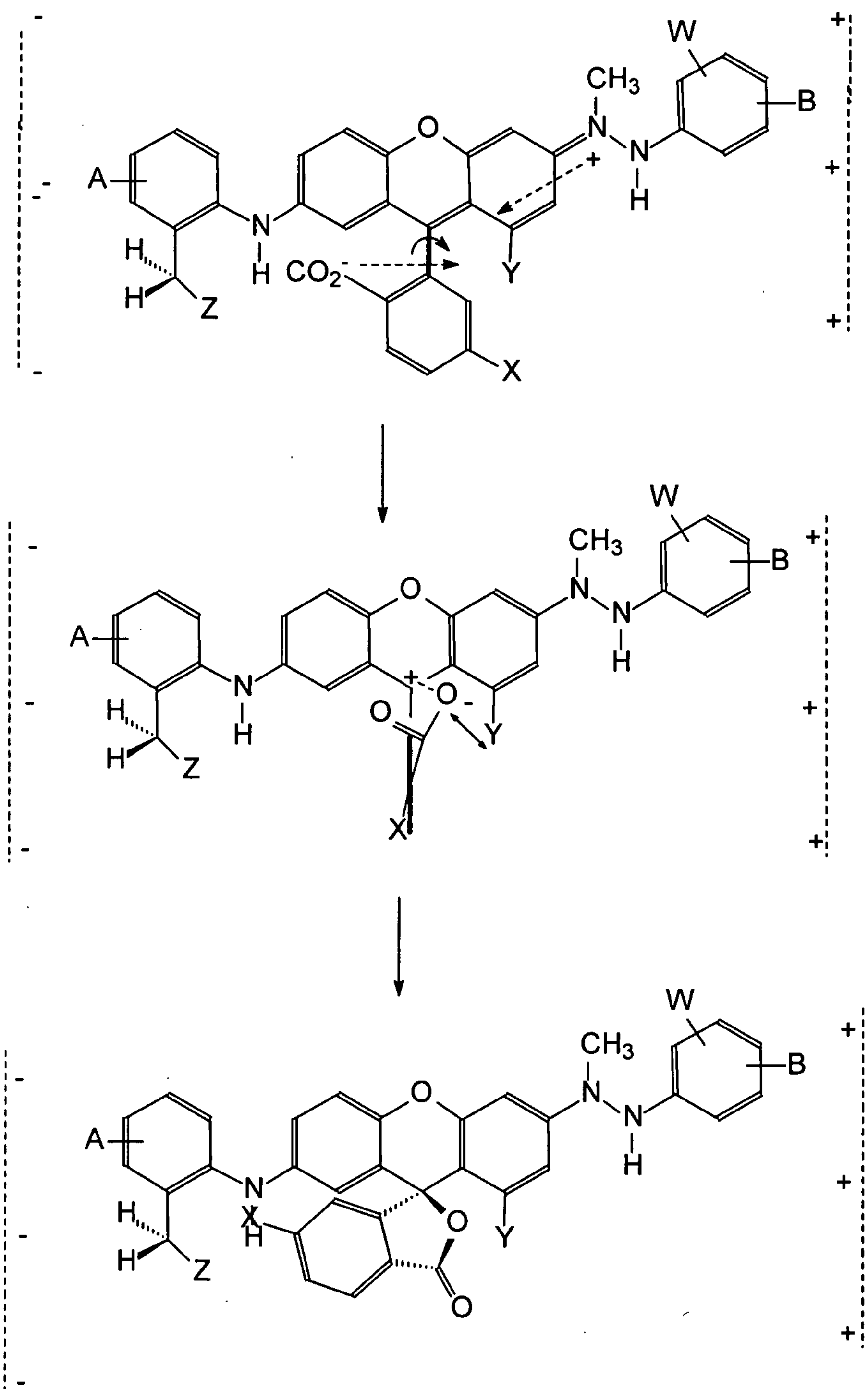
where M^+ represents metals, including transition metals, or their halogen complexes or H^+ or other type of Lewis acid(s) (Current Application page 23, line 25 to page 24, line 20). Claim 11 is directed to the molecular switch of claim 6 wherein said electric field induced band gap occurs via a change of extended conjugation via charge separation or recombination and π-bond breaking or formation (Current Application page 24, lines 28-30). Claim 12 is directed to the molecular switch of claim 11 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively larger band gap state, and wherein in said second state, said extended conjugation is changed and separated positive and negative charges are created within said molecular system, resulting in a relatively smaller band gap state (Current Application page 25, lines 1-5). Claim 13 is directed to the molecular switch of claim 12 wherein said molecular

system comprises:



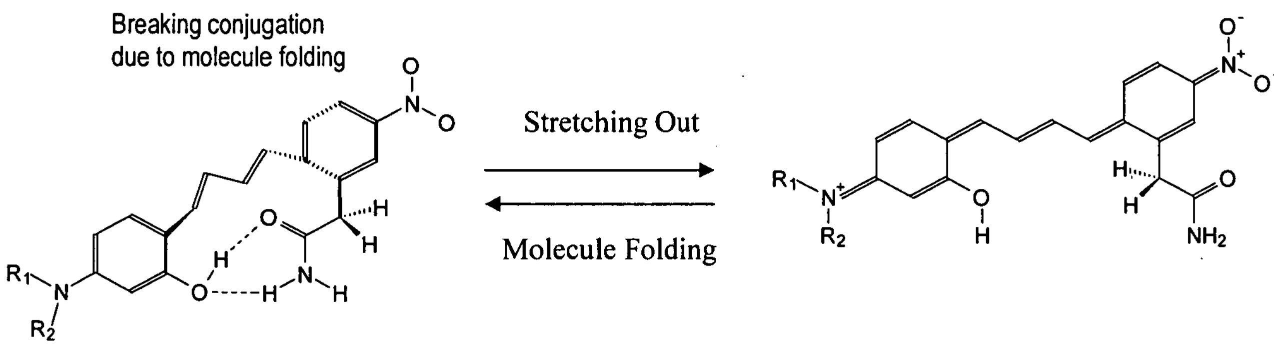


wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the vertical dashed lines represent electrodes with which said molecular system is electrically associated (Current Application page 25, line 8 to page 26, line 13). Claim 14 is directed to the molecular switch of claim 12 wherein said molecular system comprises:



wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the

vertical dashed lines represent electrodes with which said molecular system is electrically associated (Current Application page 27, line 3 to page 29, line 9). Claim 15 is directed to the molecular switch of claim 1 wherein said electric field induced band gap change occurs via molecular folding or stretching (Current Application page 31, lines 9-11, Figure 4). Claim 16 is directed to the molecular switch of claim 15 wherein said molecular system comprises three portions, a first portion and a third portion, each bonded to a second, central portion, wherein a change from a first state to a second state occurs with an applied electric field, said change involving a folding or stretching about or of said second portion, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap state, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap (Current Application page 31, lines 11-18, Figure 4). Claim 17 is directed to the molecular switch of claim 16 wherein said molecular system comprises:



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom (Current Application page 32, line 14 to page 33, line 7). Claim 18 is directed to the molecular switch of claim 1 comprising a crossed-wire device comprising a pair of crossed wires that form a junction where one wire crosses another at an angle other than zero degrees and at least one connector species connecting said pair of crossed wires in said junction, said junction having a functional dimension in nanometers, wherein said at least one connector species comprises said molecular system (Current Application paragraph 0137). Claim 19 is directed to the molecular switch of claim 18 wherein said crossed-wire device is selected from the group consisting of memories, logic devices, multiplexers, demultiplexers, configurable

interconnects for integrated circuits, field-programmable gate arrays (FGPAs), cross-bar switches, and communication devices (Current Application paragraphs 0136). Claim 20 is directed to the molecular switch of claim 1 wherein said molecular system is sandwiched between a pair of electrodes and connected thereto by linking moieties (Current Application paragraphs 0096, 0110, page 26, lines 11-13; page 29, lines 8-9).

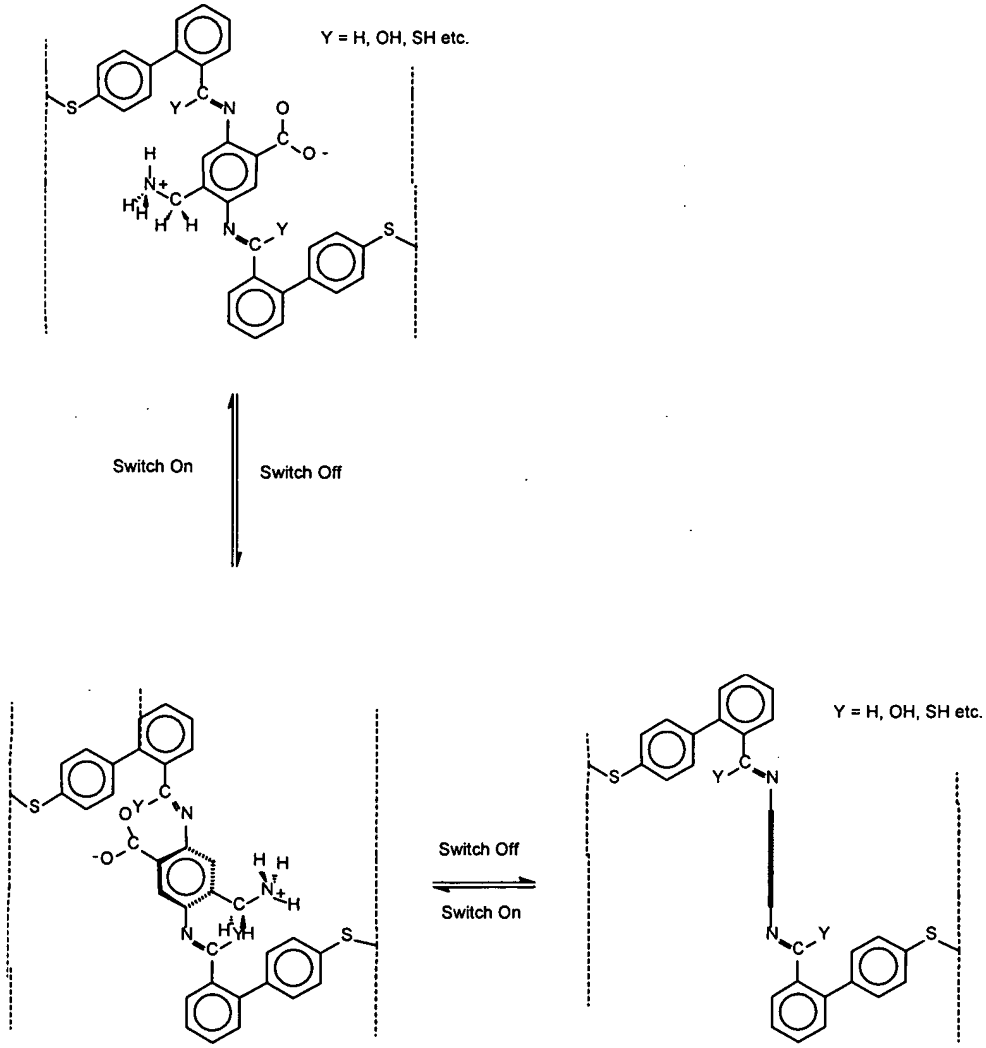
Independent Claim 21

Claim 21 is directed to a method of electrically switching between two different states in an electric field activated molecular switch comprising a crossed-wire device comprising at least one pair of crossed wires that form a junction where one wire crosses another at an angle other than zero degrees and at least one connector species connecting the pair of crossed wires in the junction, wherein the junction has a functional dimension in nanometers and wherein the connector species comprises a molecular system that has an electric field induced non-redox type of band gap change resulting from an intramolecular change in conjugation as p,π-electrons of the molecular system (Current Application page 14, lines 13-14), through its highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), are alternately localized and delocalized over the entire molecular system by the electric field, wherein said electric field induced band gap change occurs via one of the following mechanisms: (1) molecular conformation change or an isomerization (Current Application page 14, lines 7-8; page 15, lines 8-15, Figure 2); (2) change of extended conjugation via chemical bonding change to change the band gap (Current Application page 14, lines 9-10; page 21, lines 22-29, Figure 3a; page 24, line 28 to page 25, line 5, Figures 3b); or (3) molecular folding or stretching (Current Application page 14, lines 11-12; page 31, lines 9-18, Figure 4), said method comprising applying a voltage to a pair of wires to cause a change in the state of said molecular system at said junction thereof.

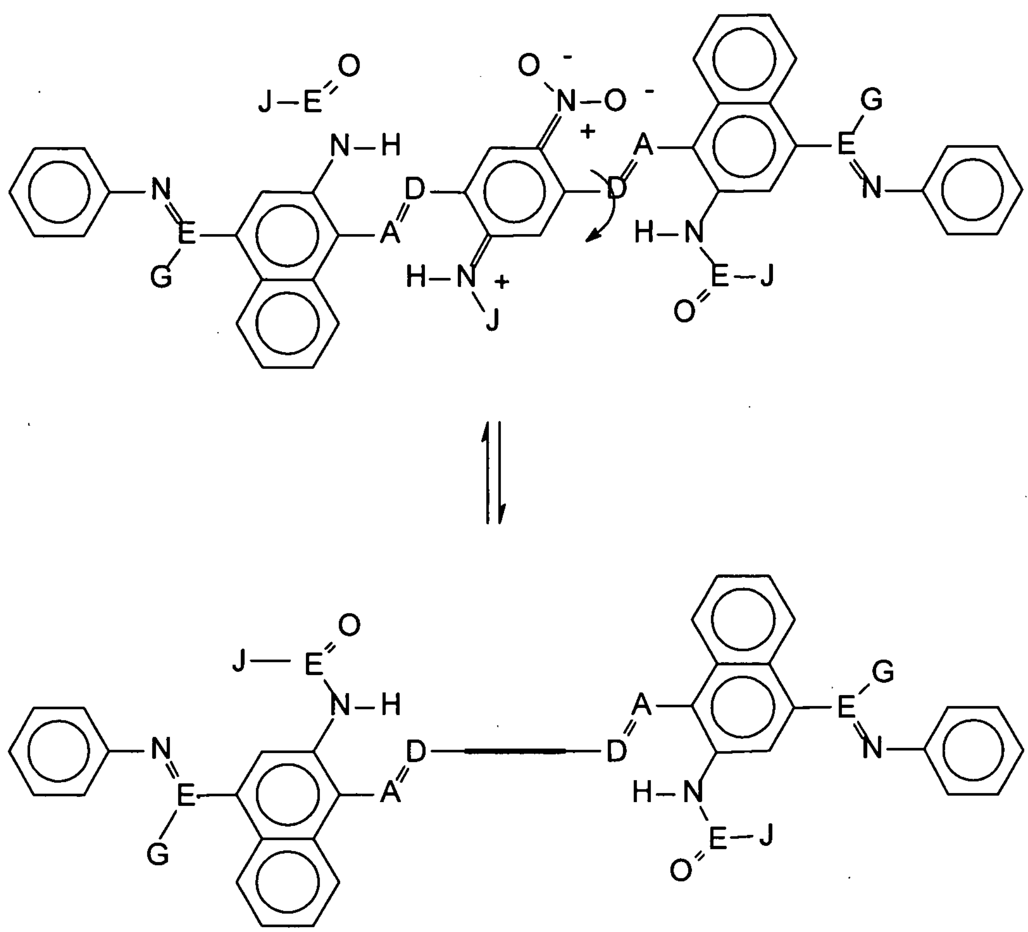
Dependent Claims 22-40

Claim 22 is directed to the method of claim 21 wherein said electric field induced band gap change occurs via molecular conformation change or an isomerization (Current Application page 16, lines 10-11). Claim 23 is directed to the method of claim 22 wherein said molecular system comprises at least one stator portion and at least one rotor portion, wherein said rotor rotates from a first state to a second state with an applied electric

field, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap (Current Application page 16, line 10 to page 17, line 12). Claim 24 is directed to the method of claim 23 wherein said molecular system comprises:

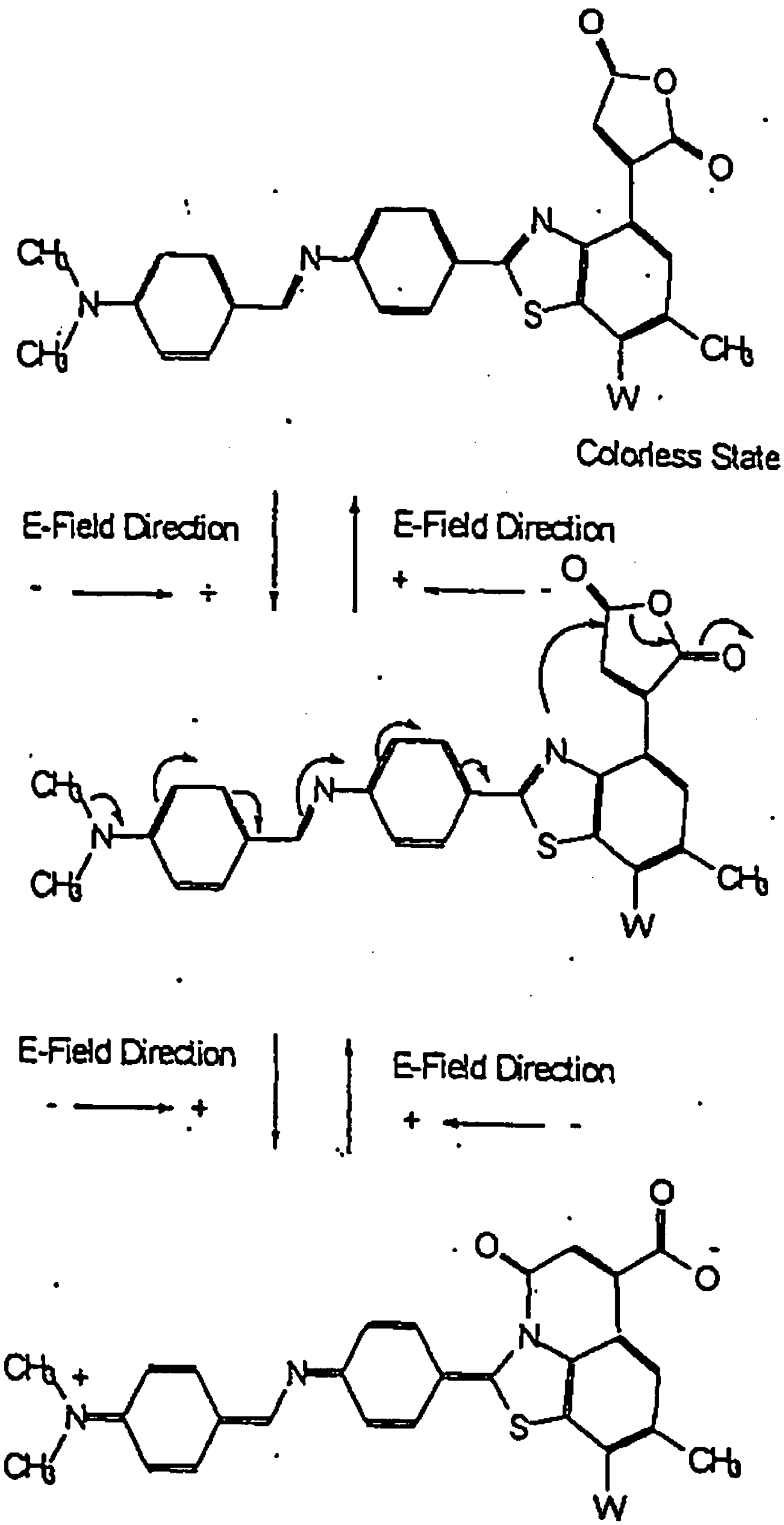


where the vertical dashed lines represent electrodes to which said molecule is electrically attached (Current Application page 17, line 13 to page 19, line 13). Claim 25 is directed to the method of claim 23 wherein said molecular system comprises:



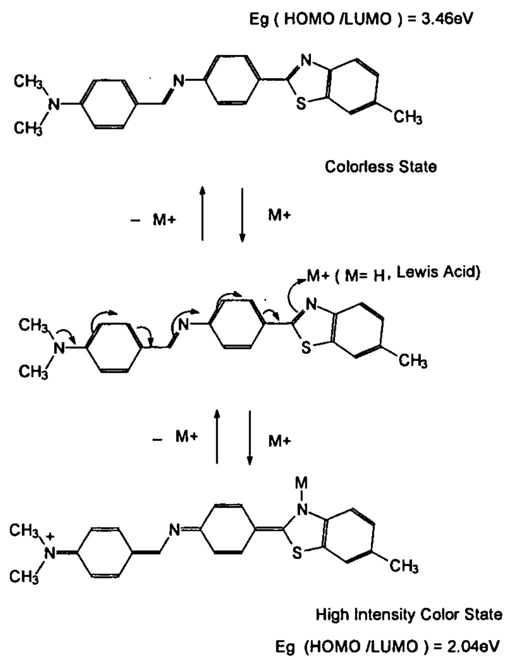
wherein the letters A, D, E, G, and J indicate sites where different chemical units can be utilized to adjust geometrical structure and optical properties of said molecular system and have generic designations as follows: A, D, E, G, and J are independently selected from the group consisting of heteroatoms, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom, and where in addition to the foregoing, the letters G and J are independently selected from the group consisting of hydrogen, F, Cl, Br, and I (Current Application page 19, line 20 to page 21, line 5). Claim 26 is directed to the method of claim 21 wherein said electric field induced band gap occurs via a change of extended conjugation via chemical bonding change to change the band gap (Current Application page 21, lines 19-21). Claim 27 is directed to the method of claim 26 wherein said electric field induced band gap change occurs via a change of extended conjugation via charge

separation or recombination accompanied by increasing or decreasing band localization (Current Application page 21, lines 22-25). Claim 28 is directed to the method of claim 27 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, thereby resulting in a relatively larger band gap state, with less π-delocalization, and recombination of charge in changing from said second state to said first state, thereby resulting in a relatively smaller band gap state, with greater π-delocalization (Current Application page 21, lines 25-29). Claim 29 is directed to the method of claim 28 wherein said molecular system comprises (Current Application page 22, line 23, to page 23, line 24):

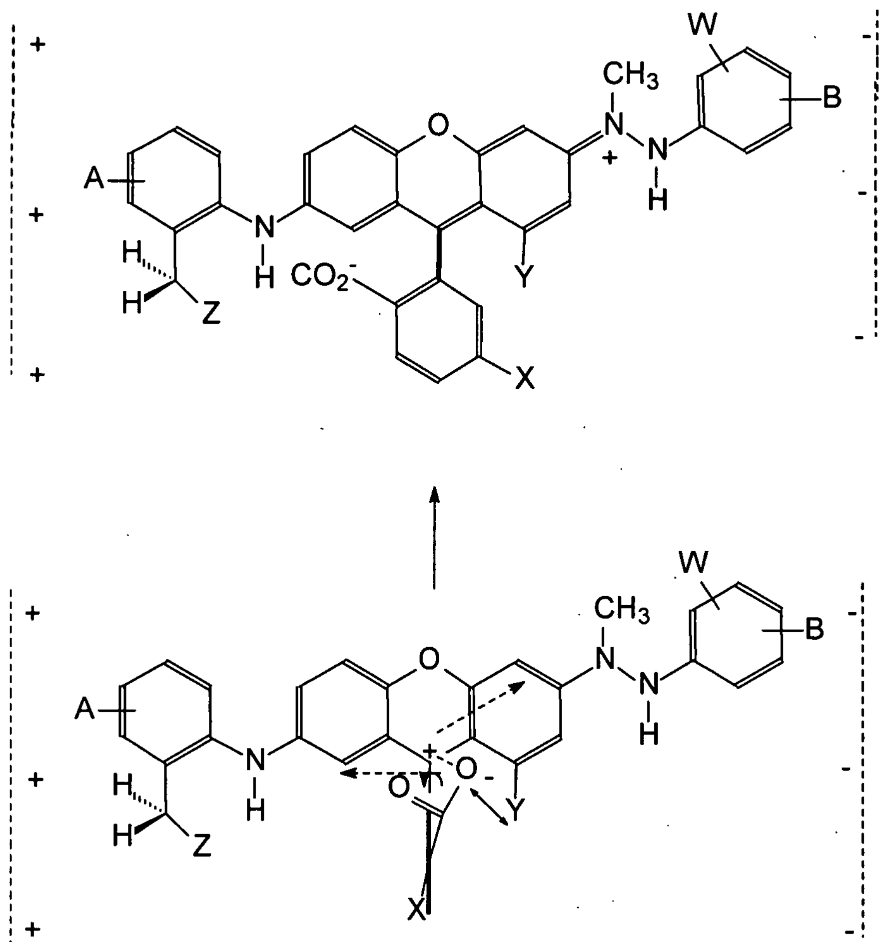


High Intensity Color State

Claim 30 is directed to the method of claim 28 wherein said molecular system comprises:



where M^+ represents metals, including transition metals, or their halogen complexes or H^+ or other type of Lewis acid(s) (Current Application page 23, line 25 to page 24, line 20). Claim 31 is directed to the method of claim 26 wherein said electric field induced band gap occurs via a change of extended conjugation via charge separation or recombination and π-bond breaking or formation (Current Application page 24, lines 28-30). Claim 32 is directed to the method of claim 31 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively larger band gap state, and wherein in said second state, said extended conjugation is changed and separated positive and negative charges are created within said molecular system, resulting in a relatively smaller band gap state (Current Application page 25, lines 1-5). Claim 33 is directed to the method of claim 32 wherein said molecular system comprises:


W
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O-
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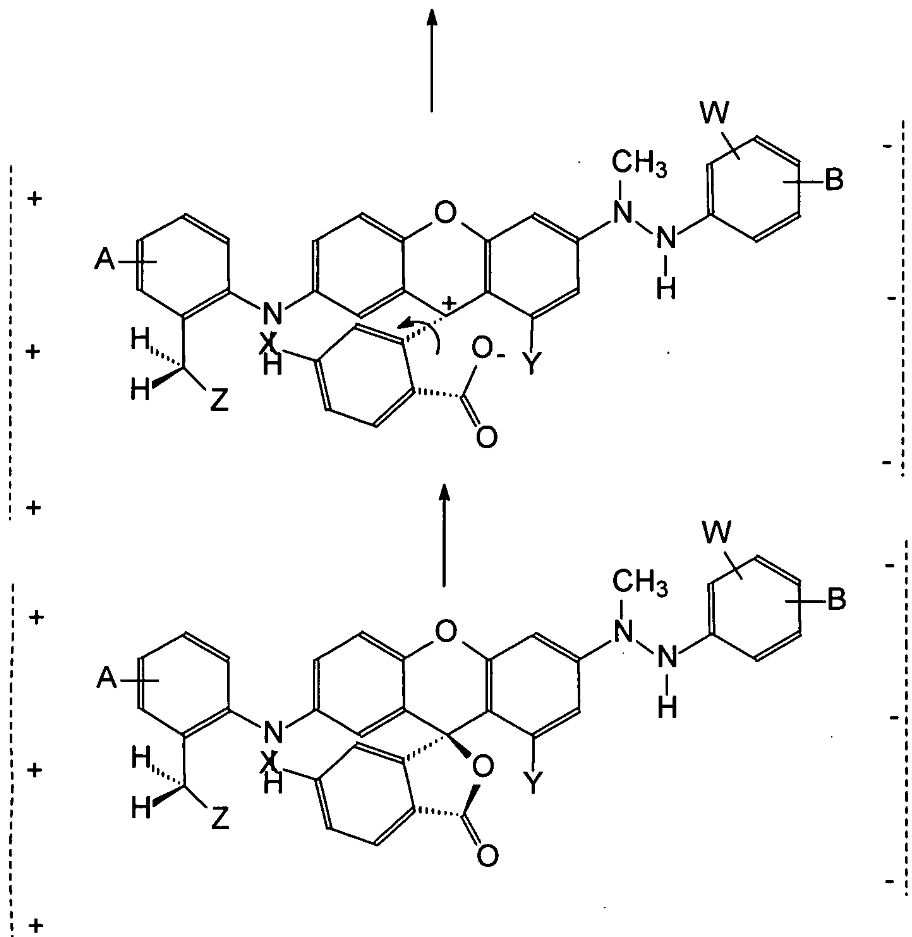
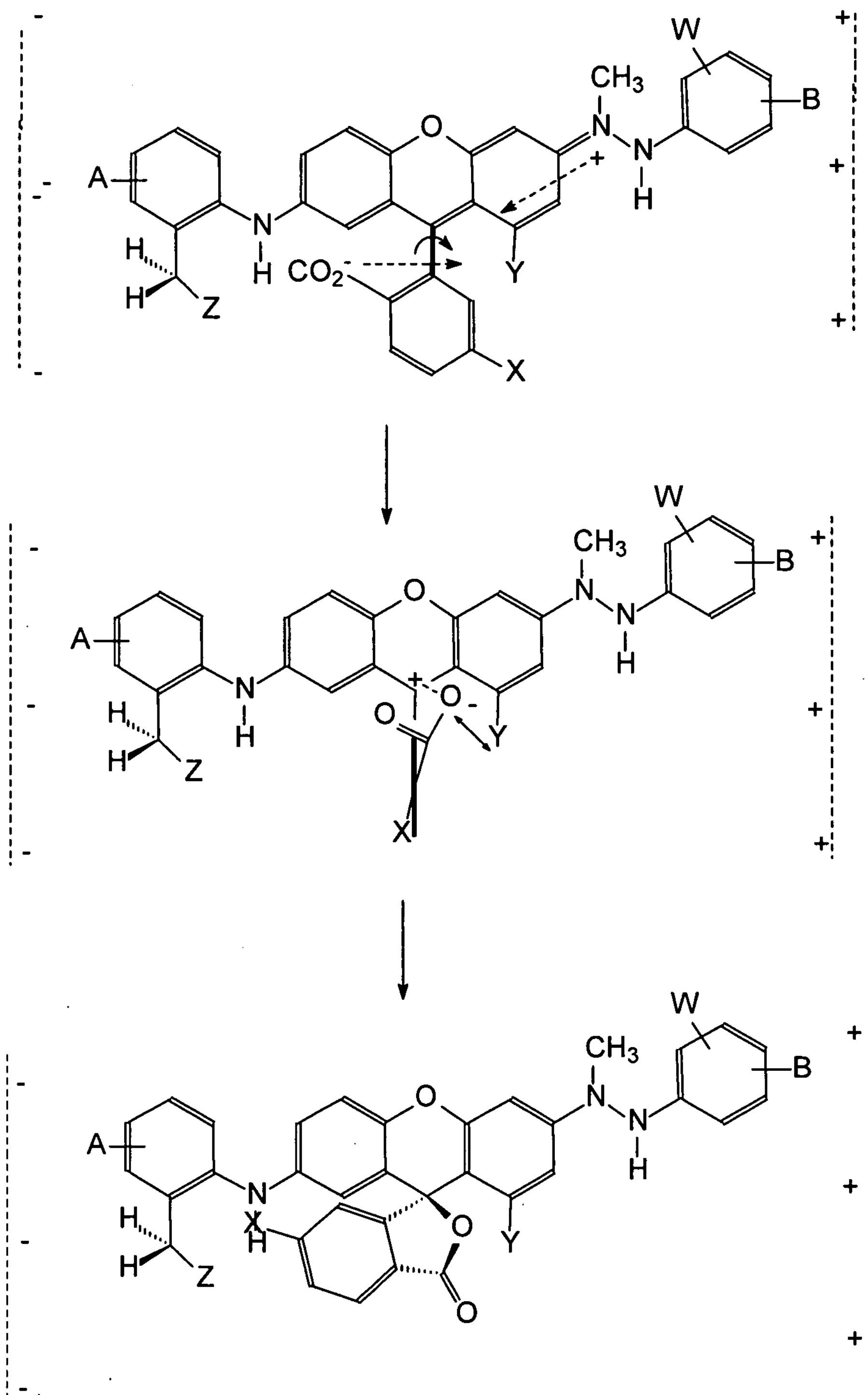
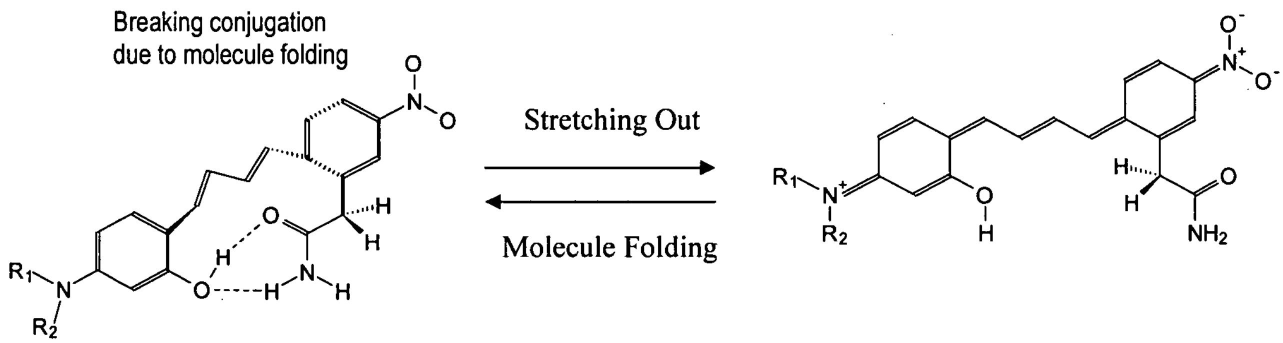


wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the vertical dashed lines represent electrodes with which said molecular system is electrically associated (Current Application page 25, line 8 to page 26, line 13). Claim 34 is directed to the method of claim 32 wherein said molecular system comprises:



wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the

vertical dashed lines represent electrodes with which said molecular system is electrically associated (Current Application page 27, line 3 to page 29, line 9). Claim 35 is directed to the method of claim 21 wherein said electric field induced band gap change occurs via molecular folding or stretching (Current Application page 31, lines 9-11, Figure 4). Claim 36 is directed to the method of claim 35 wherein said molecular system comprises three portions, a first portion and a third portion, each bonded to a second, central portion, wherein a change from a first state to a second state occurs with an applied electric field, said change involving a folding or stretching about or of said second portion, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap state, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap (Current Application page 31, lines 11-18, Figure 4). Claim 37 is directed to the method of claim 36 wherein said molecular system comprises:



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom (Current Application page 32, line 14 to page 33, line 7). Claim 38 is directed to the method of claim 21 comprising a crossed-wire device comprising a pair of crossed wires that form a junction where one wire crosses another at an angle other than zero degrees and at least one connector species connecting said pair of crossed wires in said junction, said junction having a functional dimension in nanometers, wherein said at least one connector species comprises said molecular system (Current Application paragraph 0137). Claim 39 is directed to the method of claim 38 wherein said crossed-wire device is selected from the group consisting of memories, logic devices, multiplexers, demultiplexers, configurable interconnects for

integrated circuits, field-programmable gate arrays (FGPAs), cross-bar switches, and communication devices (Current Application paragraphs 0136). Claim 40 is directed to the method of claim 1 wherein said molecular system is sandwiched between a pair of electrodes and connected thereto by linking moieties (Current Application paragraphs 0096, 0110, page 26, lines 11-13; page 29, lines 8-9).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1, 2, 20-22, and 40 are rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent 7,186,355 ("Swager").

2. Claims 3 and 23 are rejected under 35 U.S.C. §103(a) as being unpatentable over Swager as applied to claim 1.

3. Claims 1-3, 20-23, and 40 are rejected under 35 U.S.C. §103(a) as being unpatentable over IMB Tech. Discl. NN8902444 Vol. 21, No. 9, pages 444-450 in view of U.S. Patent Application 2003/0112564A1 ("Granstrom").

4. Claim 1 is rejected under 35 U.S.C. §103(a) as being unpatentable over JACS 1990, Vol. 112, pp 4192-4197 ("Hush") in view of Granstrom.

ARGUMENT

Claims 1-40 are pending in the current application. In a Final Office Action, the Examiner rejected claims 1, 2, 20-22, and 40 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent 7,186,355 ("Swager"); rejected claims 3 and 23 under 35 U.S.C. 103(a) as being unpatentable over Swager; rejected claims 1-3, 20-23, and 40 under 35 U.S.C. §103(a) as being unpatentable over IMB Tech. Discl. NN8902444 Vol. 21, No. 9, pages 444-450 ("IBM") in view of U.S. Patent Application 2003/0112564A1 ("Granstrom"); and rejected claim 1 under 35 U.S.C. §103(a) as being unpatentable over JACS 1990, Vol. 112, pp 4192-4197 ("Hush") in view of Granstrom. As discussed in more detail below, Applicant's representative traverses these rejections.

The Examiner has twice rejected claims 1-3, 20-23 and 40 of the current application based on the above cited references despite Applicants' detailed arguments with

regard to the dissimilarity of the teachings of these references from the currently claimed invention. Therefore, Applicant believes that an appeal at this time is the most expeditious vehicle for advancing prosecution. The primary object of this appeal brief is to demonstrate that Swager does not anticipate claims 1, 2, 20-22, and 40, that claims 3 and 23 are patentable over Swager, that claims 1-3, 20-23, and 40 are patentable over IBM in view of Granstrom; and that claim 1 is patentable over Hush in view of Granstrom.

ISSUE 1

1. Whether claims 1, 2, 20-22, and 40 are anticipated by U.S. Patent 7,186,355 ("Swager") under 35 U.S.C. §102(e).

Applicant's representative asserts that claims 1, 2, 20-22, and 40 are not anticipated under 35 U.S.C. §102 by Swager because the Examiner has not shown that Swager teaches a device or method satisfying the requirements of 35 U.S.C. §102 as interpreted by the long standing case law. M.P.E.P. §2131 quotes holdings from cases directed to interpreting and applying 35 U.S.C. §102 as follows:

> (1) a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently, in a single prior art reference *Verdgaal Bros. v. Union Oil Co. of California*, 814 F.2d 628 (Fed. Cir. 1987),
> (2) the identical invention must be shown in as complete detail as is contained in the claim *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226 (Fed. Cir. 1989), and
> (3) the elements must be arranged as is required by the claim, *In re Bond*, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

Swager teaches a number of different molecules and molecular devices. However, in spite of these holdings, the Examiner wrongly interprets 35 U.S.C. §102 to mean that it is the Swager reference alone that anticipates claims 1 and 21, and therefore, all that is needed to argue that Swager anticipates claims 1 and 21 is to cite passages of Swager corresponding to the elements of claims 1 and 21 without showing that Swager actually assembles these elements into a single device or method that anticipates claims 1 and 21. In addition, the Examiner ignores certain elements of claims 1 and 21 that are not found in Swager. However, according to *Verdgaal Bros*, *Richardson*, and *In re Bond*, the Examiner has to demonstrate that Swager teaches a device or method that includes each and every element of claims 1 and 21, that is described in as complete detail as contained in claims 1 and 21, and not only includes the same elements, but these elements must be arranged in the same manner as the elements in claims 1 and 21.

In the Final Office Action, the full argument the Examiner presents in asserting that claims 1 and 21 are anticipated by Swager is stated as follows:

> Swager discloses a molecular switch in which a molecule is placed between two electrodes (col. 5, lines 7-10 and 38-42). The molecule has a change in conformation or conjugation from the delocalization of electric charge with extended conjugation (col. 5, lines 43-48 and col. 7, lines 62-67 and col. 21, lines 29-34).

In other words, the Examiner contends that Swager teaches a molecular switch in col. 5, lines 7-10 and 38-42 in which a molecule is placed between two electrodes as shown in Figure 26. The Examiner contends that the molecule described in col. 5, lines 7-10 and 38-42 has the properties the molecules described in col. 5, lines 43-48; col. 7, lines 62-67 and col. 21; lines 29-34. However, Swager says no such thing. Swager says nothing about the molecule described in col. 5, lines 7-10 and 38-42 having a change in conformation or conjugation as described in col. 5, lines 43-48; col. 7, lines 62-67; and col. 21, lines 29-34. In fact, these cited passages are actually directed to different molecules and molecular devices and are neither configured nor operated in the same manner as the molecules of col. 5, lines 7-10 and 38-42.

First, consider col. 5, lines 7-10 which is actually a brief description of Figure 26 of Swager stating "FIG. 26 shows a schematic of an idealized single molecule molecular wire extending the entire length between electrodes," and col. 5, lines 38-42 state:

> The nanoscopic pathway can be an organic group, an organometallic compound, a coordination compound, a salt, a nanoparticle, a carbon nanotube, a biological species and combinations thereof.

A more detailed description of the molecular device shown in Figure 26 of Swager is provided in col. 6, lines 18-43. Figure 26 of Swager shows a polymer wire configured with receptor sites 156A-156E. These receptor sites are used to control the resistance of the wire and, in turn, control the flow of current between the electrodes 152 and 153. For example, Swager states "[b]inding of analyte 159 by receptor 156D adds resistance to the wire, as schematically indicated by energy 160." In other words, the device shown in Figure 26 is actually a detector and the flow of current, or electron charge transfer, is controlled by analytes binding to the receptor sites of the polymer wire. The change in the flow of current through the wire indicates the presence of the analyte. In contrast, claims 1 and 21 teach applying an electric field that induces an intramolecular change in conjugation as p, π-electrons which changes the band gap as is described in claims 1 and 21.

Next, consider the Examiner's references to col. 5, lines 43-48; col. 7, lines

62-67; and col. 21, lines 29-34 as describing the operation of the molecules in the device shown in Figure 26. Applicant's representative is mystified by the Examiner's choice of these passages. Swager says nothing about these passages referring to the molecule and device of Figure 26 of Swager and described in col. 5, lines 7-10 and 38-42, because the molecules and devices described in these passages are actually directed to different molecules and devices. In addition, these passages do not teach each and every element as described in claims 1 and 21.

First, col. 5, lines 43-48 state:

> In one embodiment, the nanoscopic pathway can be provided by a molecular system (e.g. an organic or organometallic group) having a bonding arrangement which affords delocalization of electronic charge extending throughout a portion or entire length of the molecule.

There is no mention in col. 5, lines 43-48 of applying an electric field to bring about a conformation change of a switch molecule as taught in claims 1 and 21.

Second, col. 7, lines 62-67 states "[t]ypically, a significant portion of the switch comprises an organic group capable of changing conformation upon charge transfer." In other words, the organic groups referred to in col. 7, lines 62-67 of Swager are capable of changing conformation using "charge transfer." Thus, Swager is not applying an electric field to change the conformation of the organic group. Instead, Swager describes in col. 7, lines 62-67 applying charge transfer or a current which, in turn, causes the conformation change.

Third, the conjugation referred to in col. 21, lines 29-34 does not teach the change in conjugation referred to in claims 1 and 21. Col. 21, lines 29-34 are actually the last two sentences of a paragraph beginning with line 22 of col. 21 and is reproduced as follows:

> This example presents another approach to design monomers that can be both electropolymerized and cyclized in a tandem process. Thiophene groups can be attached in one of two fashions, either through the position α or β to the sulfur. In the first case cyclization as shown (top) in FIG. 17 proceeds through the less reactive β-position and the polymerization can occur through the α-position. In this polymer the only conjugation path involves the phenyl ring resulting in a higher band-gap and higher oxidation potential. In the case shown (bottom) in FIG. 17 the cyclization and polymerization both occur through the more reactive α-positions. A conjugation path exists through the thiophene residues and these systems are easier to oxidize and have lower band gaps.

As stated in the first sentence on line 22, this paragraph describes electropolymerization and

cyclization. Polymerization is a process of bonding a number of monomers (i.e., single molecular units) together to form a longer chain molecule called a "polymer." Cyclization is the same process but the monomers are bound together to form a molecular ring or cyclic polymer. The paragraph of col 21, lines 22-34 describes polymerization and cyclization using the thiophene groups, shown in Figure 17, as monomers. Thiophene groups can be bonded together to form a polymer in one of two fashions, either through the α-position or β-position to the sulfur atoms, as shown in Figure 17. Swager describes cyclization as proceeding through the less reactive β-position, and that polymerization can occur through the α-position. In both cases, the band gaps associated with the resulting polymers are determined by the α- and β-position of the monomers. In other words, the band gaps are associated with the α- and β-position of the monomers used to form the polymer and cyclic polymers. However, there is no mention in col. 21, lines 22-35 of applying an electric field to induce a change in the conjugation of molecules or band gap of a molecular switch, as is taught by claims 1 and 21.

In fact, Swager does not mention using an electric field to induce a band gap change that occurs via one of the following mechanisms: (1) molecular conformation change or an isomerization; (2) change of extended conjugation via chemical bonding to change the band gap; or (3) molecular folding or stretching. In addition, the Examiner has not demonstrated that Swager teaches a single device or method that includes each and every element arranged in the same manner and in as complete detail as the elements of claims 1 and 21.

In response to the above arguments, the Examiner states in the Response to Arguments section of the Final Office Action, that "Swager does disclose a teaching that the molecular switch produces a current when placed in an electric field (col. 22, lines 55-59)." The citation col. 22, line 55-59 is actually the last sentence of a paragraph beginning in col. 22, line 46 which states:

> Polymer 92 can also be used as a conjugated polymer template. Polymer 92, a very electron-poor polymer previously synthesized (Marsella et. al. Advanced Materials 7, 145 147, 1995), is an efficient threading element for the formation of polyrotaxane complexes. The resultant ladder polymers will have electron-rich and electron-poor polymers with close co-facial contacts. Photoexcitation will transfer an electron to 92 from the macrocycle containing polymer, and the conjugated nature of both polymers will allow for the carriers to rapidly diffuse away from each other and hence produce long lived charge separation. This charge separation should produce an accompanying photocurrent when placed between two electrodes in an electric field.

This is the only reference in Swager to an electric field. Swager is actually teaching that the electric field induces a current. In contrast, as clearly explained in the detailed description and as stated in claims 1 and 21, the electric field of claims 1 and 21 is not used to generate a current. Instead the electric field of claims 1 and 21 is applied to induce "band gap changes" that occur "via one of the following mechanisms: (1) molecular conformation change or an isomerization; (2) change of extended conjugation via chemical bonding change to change the band gap; or (3) molecular folding or stretching." A conformation or conjugation change in a molecule is not the same as a current passing through the molecule. The Examiner's statement is an indication that the Examiner does not appear to fully understand the invention as described in claims 1 and 21. The Examiner's reference to col. 22, lines 55-59 is once again another reference to a device, described in EXAMPLE 11 of Swager, that does not include other elements of claims 1 and 21 and is not related to the device shown in Figure 26 of Swager.

In the Response to Arguments section of the Final Office Action, the Examiner also states that:

> Applicant has argued that Swager described a number of different kinds of molecular devices . . . . This argument is respectfully found not to be persuasive because patents are relevant as prior art for all that they contain (MPEP 2123). Therefore, the broad disclosure made by Swager and not only the individual examples are applied to reject the claims.

This statement indicates that the Examiner is confused as to how to properly apply 35 U.S.C. §102. The Examiner statement that "patents are relevant as prior art for all that they contain" in MPEP 2123 is a paraphrasing of an actual holding which states:

> The use of patents as references is not limited to what the patentees describe as their inventions or to the problems with which they are concerned. They are part of the literature of the art, relevant for all they contain. *In re Heck* 699 F.2d 1331, 1333 (quoting *In re Lemelson*, 397 F.2d 1006, 1009).

This holding as recited in *In re Heck* and *In re Lemelson* is being taken out of context by the Examiner. A thorough reading of *In re Heck* and *In re Lemelson* reveals that these cases are directed to prior art references cited in obviousness rejections under 35 U.S.C. §103(a) and are not directed to references cited in anticipation rejections under 35 U.S.C. §102. In order to avoid inappropriate application of a case holding, the holding should not be applied outside the context of the original facts and arguments presented in the case. However, the Examiner

is wrongly interpreting the holding stated in *In re Heck* and *In re Lemelson* as giving license to combining elements from different devices described in a single prior art reference in making a 35 U.S.C. §102 rejection. This interpretation of *In re Heck* and *In re Lemelson* contradicts the already established holdings from actual cases, such as *Verdgaal Bros.*, *Richardson,* and *In re Bond* cited above, which are directed to interpreting 35 U.S.C. §102. Applicant's representative is not suggesting that the Examiner not consider the entire Swager reference in determine whether claims 1 and 21 are anticipated under 35 U.S.C. §102. Instead, Applicant's representative is merely asserting that it is the Examiner's burden to show that each and every element of claims 1 and 21 can be found in Swager in as complete detail and arranged as in claims 1 and 21. It is Applicant's contention that the Examiner's attempt to combine elements from different devices and methods of a single prior art reference in an attempt to establish anticipation under 35 U.S.C. §102 is an inappropriate application of 35 U.S.C. §102.

Because the Examiner has not been able to demonstrate that Swager teaches of a device and method in accordance with a proper application 35 U.S.C. §102(e), Swager does not anticipate claims 1 and 21 under 35 U.S.C. §102(e). Dependent claims 2, 3, and 20 are not anticipated by Swager as depending from allowable base claim 1, and claims 22, 23, and 40 are not anticipated by Swager as depending from allowable base claim 21.

ISSUE 2

2. Whether claims 3 and 23 are unpatentable over Swager as applied to claim 1under 35 U.S.C. §103(a).

The Examiner rejected claims 3 and 23 under 35 U.S.C. 103(a) as being unpatentable over Swager. In particular, the Examiner's entire argument is presented in the following two sentences:

> Swager is silent with respect to a rotor portion.
>
> [I]t would have been obvious to one of ordinary skill in the art at the time of the invention that the disclosure made by Swager et al encompasses a molecule with stator and rotor portions because Fig. 19 and Fig. 20 show molecules which have bonds which have groups which can rotate.

It is applicant's contention that the Examiner has failed to provide the necessary facts and analysis needed to conclude that a molecule with stator and rotor portions is obvious based on viewing the molecules represented in Figures 19 and 20 of Swager.

According to the M.P.E.P. §2141 II, Examiners

> fulfill the critical role of fact finders when resolving the *Graham* inquiries. When making an obviousness rejection, Office personnel must therefore ensure that the written record includes findings of fact concerning the state of the art and the teachings of the references applied. Factual findings made by Office personnel are the necessary underpinnings to establish obviousness (emphasis added).

In addition, according to the M.P.E.P. §2141 III

> [t]he key to supporting any rejection under 35 U.S.C. §103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR* noted that the analysis supporting a rejection under 35 U.S.C. 103 should be made explicit. The Court quoting *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006), stated the "Rejections on obviousness cannot be sustained by mere conclusory statements; instead there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR* 550 U.S. at ___, 82 USPQ2d at 1396 (emphasis added).

Thus, according to M.P.E.P. §2141 II and III, the burden is on the Examiner to provide facts and an analysis of the facts in support of why claims 3 and 23 are unpatentable over Swager. Applicant contends that the Examiner has not provided the facts and analysis in support of the conclusory statement that stator and rotor portions of a molecule are obvious "because Fig. 19 and Fig. 20 show molecules which have bonds which have groups which can rotate" in rejecting claims 3 and 23 as being unpatentable over Swager.

A rotor is a segment of a molecule having a relatively large dipole moment that links two other immobilized portions of the same molecule. The immobilized portions are called stators. Under the influence of an applied electric field, the vector dipole moment of the rotor rotates with respect to the stators in an attempt to align parallel to the direction of the external electric field (Current Application, paragraph 0088).

In contrast, the molecules shown in Figure 19 are monomers that can be used to form polymers as Swager explains in EXAMPLE 10 (see col. 21, lines 17-67). The monomers do not include stator and rotor groups. There is no mention in the description of EXAMPLE 10 of the monomers shown in Figure 19 including stator or rotor groups or a portion of these molecules rotating under the influence of an external electric field. It is not clear from the Examiner's single sentence statement how one who is skilled in the art can simply look at the monomers shown in Figure 19 and leap to the molecules of claims 3 and 23 comprising stator and rotor groups.

In addition, the molecules of Figure 20 do not include stators and rotors.

Figure 20 shows rotaxanes which comprise separate macrocycle and dumbbell molecules. The macrocycle portion of the rotaxane wraps around the dumbbell portion of the rotaxane. The macrocycle and dumbbell portions are separate molecules. In contrast, stators and rotors are portions of the same molecule. Again, it is not clear from the Examiner's single sentence statement how one who is skilled in the art can simply look at the macrocycle and dumbbell molecules of the rotaxanes shown in Figure 20 and leap to the molecules of the claims 3 and 23 comprising stator and rotor groups.

According to M.P.E.P. §2141 II and III, the burden is on the Examiner to provide facts and analysis in support of obviousness rejections. In other words, the Examiner cannot provide simple conclusory statements to support an obviousness rejection under 35 U.S.C. §103(a). Instead, the Examiner offers only a single conclusory statement to justify the rejection of claims 3 and 23 as being unpatentable over Swager.

Thus, the Examiner has failed to meet the burden of establishing that claims 3 and 23 are unpatentable over Swager.

ISSUE 3

3. Whether claims 1-3, 20-23, and 40 are unpatentable over IMB Tech. Discl. NN8902444 Vol. 21, No. 9, pages 444-450 ("IBM") in view of U.S. Patent Application 2003/0112564A1 ("Granstrom") under 35 U.S.C. §103(a).

The Examiner rejected claims 1-3, 20-23, and 40 under 35 U.S.C. 103(a) as being unpatentable over IBM in view of Granstrom. In particular, the Examiner contends, that

> The IBM Tech. Discl. Bull. discloses a molecular switch. The switch is activated by an applied electric field . . . The reference further discloses that there is a transition between initial and final states . . . [IBM] disclosed that the molecule may be between two electrodes. The band gap change is attributed to tunneling in an electric field.
>
> The IBM Tech. Discl. Bull. is silent with respect to the recited mechanism for change of the band gap.
>
> It would have been obvious to one of ordinary skill in the art at the time of the invention that the molecule used in the invention disclosed by IBM Discl. Bull. could have been a molecule with conjugation change because Granstrom teaches that while tunneling is a mechanism for band gap change in an electric field, the use conjugation in molecules leads to greater conductance (paragraph 0055 and 0041).

Thus, the Examiner is combining switch and electric field operation of the switch described in IBM with the molecules of Granstrom described in paragraphs 0055 and 0041 to reject claims 1-3, 20-23, and 40 under 35 U.S.C. 103(a).

According to M.P.E.P. §2143 A, in light of *KSR International Co. v. Teleflex Inc.*, in order

> [t]o reject a claim based on this rationale, Office personnel must articulate . . . a finding that the prior art included each element claimed, although not necessarily in a single prior art reference, with the only difference being the lack of actual combination of the elements in a single prior art reference.

M.P.E.P. §2143 A also states the "[t]he rationale to support a conclusion that the claim would have been obvious is that all the claimed elements were known in the prior art." In conclusion, "[i]f any of these findings cannot be made, then this rationale cannot be used to support a conclusion that the claim would have been obvious to one of ordinary skill in the art."

The Examiner contends that the conjugated molecule taught by Granstrom could be subjected to the electric field produced by the electrodes of IBM. In paragraph 0055, Granstrom states the following:

> In one embodiment of the above method, the selected organic molecules have a phenol group between two opposing thiol-capped alkyl chains. Derivatizing such molecules by changing the bonding of thiol-capped alkyl chains from sp3 hybridized orbitals to sp2 hybridized orbitals allows for conjugation, and thus a greater relative conductance through the derivatized molecules.

An alkyl groups comprises a chain of hydrocarbons with a general formula C_nH_{2n+1}. A single carbon atom in an alkyl chain having sp3 orbitals is represented by –[CH_2]-, and a single carbon atom in a conjugated chain having sp2 orbitals is represent by –[CH]-, where dashes "-" represent binding to another carbon hydrogen atom in the alkyl chain. Changing the orbitals in an alky chain from sp3 hybridized orbitals to sp2 hybridized orbitals requires a chemical elimination reaction resulting in the loss of hydrogen. Any organic chemistry textbook teaches that switching between an alkyl sp3 hybridized orbital and an sp2 hybridized orbital requires a chemical reaction where hydrogen is either eliminated or added (See for example, Organic Chemistry, Elimination reactions pages 208-217, by L.G. Wade, Prentice Hall, Inc. 1987).

However, neither IBM nor Granstrom teach or suggest "changing the bonding of thiol-capped alkyl chains from sp3 hybridized orbitals to sp2 hybridized orbitals" using an

electric field. The Examiner offers no factual basis or analysis as is required under M.P.E.P. §2141 II and III as to how changing the bonding of thiol-capped alkyl chains from sp3 hybridized orbitals to sp2 hybridized orbitals can be accomplished with an electric field supplied by the electrodes of IBM. The Examiner offers no evidence that the molecule described in paragraph 0055 can provide the kind of fast switching capabilities offered by the devices and methods described in claims 1 and 21. Examples of molecules that can be placed between two electrodes and where applying an electric field changes the chemical bonding from sigma-bonds to pi-ponds, without eliminating atoms from the final state of the molecules are described in the detailed description starting on page 21, line 19 and ending on page 31, line 6. These same molecules are also claimed in objected claims 4-19, 24-39.

The Examiner also cites paragraph 0041 of Granstrom, which states:

> Molecular monolayer 46 as shown in FIG. 4 has direct contact with magnetic layers 42 and 44. The chemical and physical nature of such contact varies according to many factors including: 1) the type of molecules that form molecular monolayer 46; 2) the type of the materials that form magnetic layers 42 and 44; and 3) the exact conditions and process to form molecular monolayer 46. Generally, the contact between molecular monolayer 46 and magnetic layer 42 or 44 can be characterized as one of the following, in a decreasing order of contact strength: covalent chemical bond, weaker charge transfer bond and van der Waals bond. When a covalent chemical bond or a charge-transfer is formed between molecular monolayer 46 and magnetic layer 42 or 44, the chemical or physical properties of the molecules in molecular monolayer 46 may become different from their inherent properties when observed as a pure compound. For example, an electrically insulating molecule may become conductive or semiconductive when it forms such strong bonds with magnetic layer 42 or 44. Conductivity of a molecule relates to the band gap between the lowest energy states of the conduction band and the highest energy states of the valence band. Strong bonding with other molecules changes the conductivity of the molecule by changing its band gap. In this sense, the electronic properties of a monolayer can be refined by making a specific type of contact with an adjacent layer such as magnetic layer 42 and/or 44 in FIG. 4. This transformation of properties provides another dimension of freedom in designing magnetoresistive element 40. The above-described transformation does not always occur, however. In a simplest form, the organic molecules may retain their intrinsic conductivity (such as a semiconductor) in contact with the magnetic layers.

In summary, paragraph 0041 merely describes how molecular monolayer 46 binds to magnetic layers 42 and 44, shown in Figure 4 of Granstrom. In particular, Granstrom teaches covalent chemical bonding, weaker charge transfer bonding, and van der Waals bonding as the three ways in which the molecules comprising the molecular monolayer 46 can bind to the magnetic layers 42 and 44. Granstrom then describes how the type of bonding can change conformation of the molecules which affects the band gap, and therefore, the

conductivity of molecular monolayer 46. However, Granstrom does not teach or suggest using an electric field to change the conformation, and therefore, the band gap of the molecular monolayer 46. As clearly explained in paragraph 0041 the change in conformation of the molecular monolayer 46 is due to chemical bonding with the magnetic layers 42 and 44 and is not due to applying an electric field. The Examiner offers no factual evidence or analysis under M.P.E.P. §2141 II and III as to how the molecular layer 46 in the presences of an electric field accomplishes the same kinds of switching described in claims 1 and 21.

In contrast, Applicants' claim in claims 1 and 21 electric field activated molecular switches where the switching mechanism is accomplished by applying an electric field that changes the extended conjugation of the molecule by (1) molecular conformation change or an isomerization; (2) change of extended conjugation via chemical bonding change to change the band gap; or (3) molecular folding or stretching. In one switch state, Applicants' molecules are fully conjugated (*i.e., pi electrons are delocalized over the entire molecule*), while in another switch state, that conjugation is altered (*i.e., pi electrons are localized to regions of the molecule*); see, *e.g.*, paragraphs 0081 and 0083. The Examiner has not identified a single molecule of Granstrom that under the influence of an applied electric field undergoes a molecular conformation change or an isomerization, a change of extended conjugation via chemical bonding change to change the band gap, or molecular folding or stretching. In fact, nowhere in Granstrom is there mention of applying an electric field to any of the molecular systems taught by Granstrom, and the Examiner has offered no evidence that teaches or suggests the molecular systems of Granstrom have the switching properties of the claims 1 and 21 when exposed to an electric field.

The Examiner cited Granstrom in the Office Action dated August 20, 2007, in order to support of the Examiners *prima facie* case for obviousness. However, the Granstrom filing date post dates the filing date of the current application. The Examiner contends in the Office Action that although Granstrom does not predate the filing date of the current application, Granstrom need not do so because Granstrom shows a universal scientific fact (see M.P.E.P. §2124). Note the Examiner does not state what this universal scientific fact is. According to M.P.E.P. §2141 II, the burden is on the Examiner to present facts. However, the Examiner has failed to do so. Instead, Applicant's representative is left to guess based on the Examiner's arguments that the Examiner is presenting paragraph 0055 as providing factual evidence. Applicant's representative also contends that the Examiner has misapplied M.P.E.P §2124. M.P.E.P. §2124 is directed to references or publications that present factual evidence. In

particular, M.P.E.P. §2124 states that "[i]n certain circumstances, references cited to show a universal fact need not be available as prior art," and "some specific examples in which later publications showing factual evidence can be cited include (1) that as of an application's filing date, undue experimentation would have been required, or (2) that a parameter absent from the claims was or was not critical, or (3) that a statement in the specification was inaccurate, or (4) that the invention was inoperative or lacked utility, or (5) that characteristics of prior art products were known." However, paragraph 0055 of Granstrom is merely a statement and does not show a universal scientific fact that predates the filing of the current application and does not reference any authoritative reference to support the statement made in paragraph 0055. Granstrom also does not fall into any of the instances stated in M.P.E.P. §2124 where it is appropriate to apply references that post date the current application. Therefore, if the Examiner wants to provide a reference in accordance with M.P.E.P §2124, this reference must show or present factual evidence supporting Granstrom's statement in paragraph 0055 or Granstrom itself must provide this factual evidence, which it does not. Applicant's representative contends that because Granstrom post dates the current application and does not include any factual evidence or data in support of paragraph 0055, the Examiner does not have a basis for using Granstrom, and Granstrom cannot be used to establish that the single statement alone in paragraph 0055 is indeed a universal scientific fact.

Thus, the Examiner has not meet the burden of establishing that claims 1 and 21 are unpatentable over IBM in view of Granstrom. In addition, claims 2, 3, 20, 22, 23 and 40 are also patentable over IBM in view of Granstrom as depending from allowable base claims 1 and 21.

ISSUE 4

4. Whether claim 1 is unpatentable over JACS 1990, Vol. 112, pp 4192-4197 ("Hush") in view of Granstrom under 35 U.S.C. §103(a).

The Examiner rejected claim 1 under 35 U.S.C. §103(a) as being unpatentable over Hush in view of Granstrom. In particular, the extent of the Examiner's argument provided in the Final Office Action is as follows:

> Hush et al discloses field activated intramolecular configurational change in molecules and that the molecules are molecular switches which can be used in logic circuits and therefore can be used in memory devices (page 419s, second paragraph in the first column, and page 4197, first column).

> Hush is silent with respect to the recited mechanism for the change in band gap.
>
> It would have been obvious to one of ordinary skill in the art to have used molecules with conjugation such as disclosed by Granstrom in the disclosure made by Hush et al because Granstrom discloses that this increases conductivity.

Although the Examiner stated the Office Action dated claim 1 is rejected under 35 U.S.C. §102(b) as being anticipated by Hush in view of Granstrom, Applicant's representative still assumes that the Examiner actually meant that claim 1 is rejected under 35 U.S.C. §103(a) as being unpatentable over Hush in view of Granstrom.

Applicant's representative contends that claim 1 is patentable over Hush in view of Granstrom. The Examiner here also contends that the conjugated molecule taught by Granstrom could be subjected to the electric field taught by Hush. As explained above, the Examiner offers no factual basis or analysis as is required under M.P.E.P. §2141 II and III as to how changing the bonding of thiol-capped alkyl chains from sp3 hybridized orbitals to sp2 hybridized orbitals can be accomplished with an electric field supplied by the electrodes of IBM. The Examiner offers no evidence that the molecule described in paragraph 0055 can provide the kind of fast switching capabilities offered by the devices and methods described in claims 1 and 21. In addition, the Examiner offers no factual evidence or analysis under M.P.E.P. §2141 II and III as to how the molecular layer 46 described in paragraph 0046 of Granstrom in the presence of an electric field accomplishes the same kinds of switching described in claims 1 and 21. The Examiner has not identified a single molecule of Granstrom that under the influence of an applied electric field undergoes a molecular conformation change or an isomerization, a change of extended conjugation via chemical bonding to change the band gap, or molecular folding or stretching.

Thus, the Examiner has not met the burden of establishing that claim 1 is unpatentable over Hush in view of Granstrom.

CONCLUSION

Applicants would not choose to bear the financial and time costs of the process in order to attempt to patent an invention that is identical to another or is obvious. Applicants are highly regarded and educated electrical engineers, chemists, and physicists. The Examiner wrongly interprets 35 U.S.C. §102 to mean that it is the reference that anticipates claims, and therefore, wrongly assumes that an argument can be made to anticipate claims by

simply citing passages corresponding to the elements of the claims without describing how the reference assembles the cited passages into a single device or method that anticipates the claims. In addition, the Examiner cannot ignore elements of claims that are not found in the reference. It is also not enough for an obviousness rejection to conclude that because two references describe different devices that have a few elements in common with the claims of the current application, the references can simply be combined to make the claims obvious. As discussed above, the claims are quite distinct and dissimilar from the devices of Swager, IBM Granstrom, and Hush and these differences are explicitly reflected in the language of the current claims. In addition, the Examiner has provided very little in the way of fact finding and analysis in support of the Examiner's rejections. As demonstrated above, the M.P.E.P. and current case law clearly place the burden of establishing anticipation and obviousness on the Examiner. The Examiner cannot assert that a claim is anticipated or obvious by simply referencing a few paragraphs and Figures of prior art references without also citing facts and providing an explanation as to how the references actually support the Examiner's conclusion.

Applicant respectfully submits that all statutory requirements are met and that the present application is allowable over all the references of record. Therefore, Applicant respectfully requests that the present application be passed to issue.

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CLAIMS APPENDIX

1. An electric field activated molecular switch comprising a molecular system that has an electric field induced non-redox type of band gap change resulting from an intramolecular change in conjugation as p,π-electrons of the molecular system, through its highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), are alternately localized and delocalized over the entire molecular system by an applied electric field, wherein said electric field induced band gap change occurs via one of the following mechanisms:

(1) molecular conformation change or an isomerization;

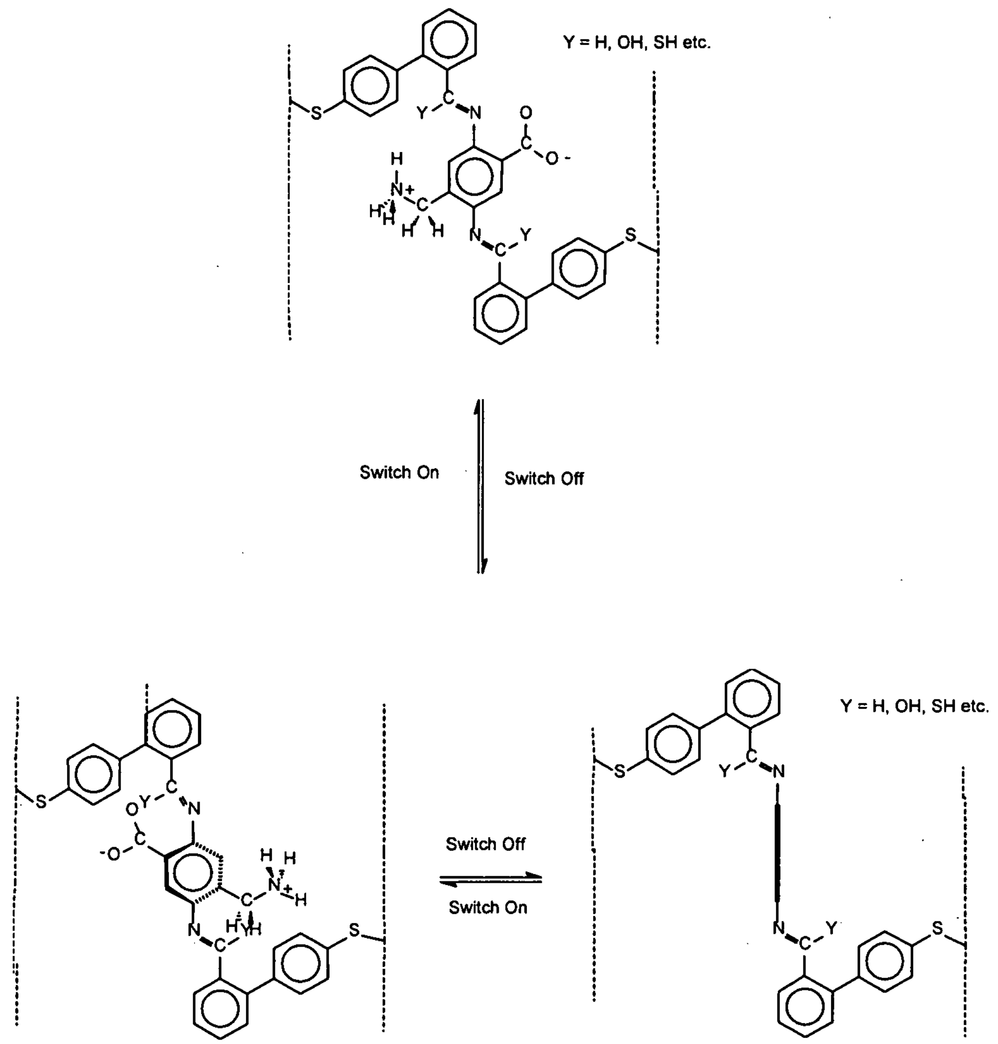
(2) change of extended conjugation via chemical bonding change to change the band gap; or

(3) molecular folding or stretching.

2. The molecular switch of Claim 1 wherein said electric field induced band gap change occurs via molecular conformation change or an isomerization.

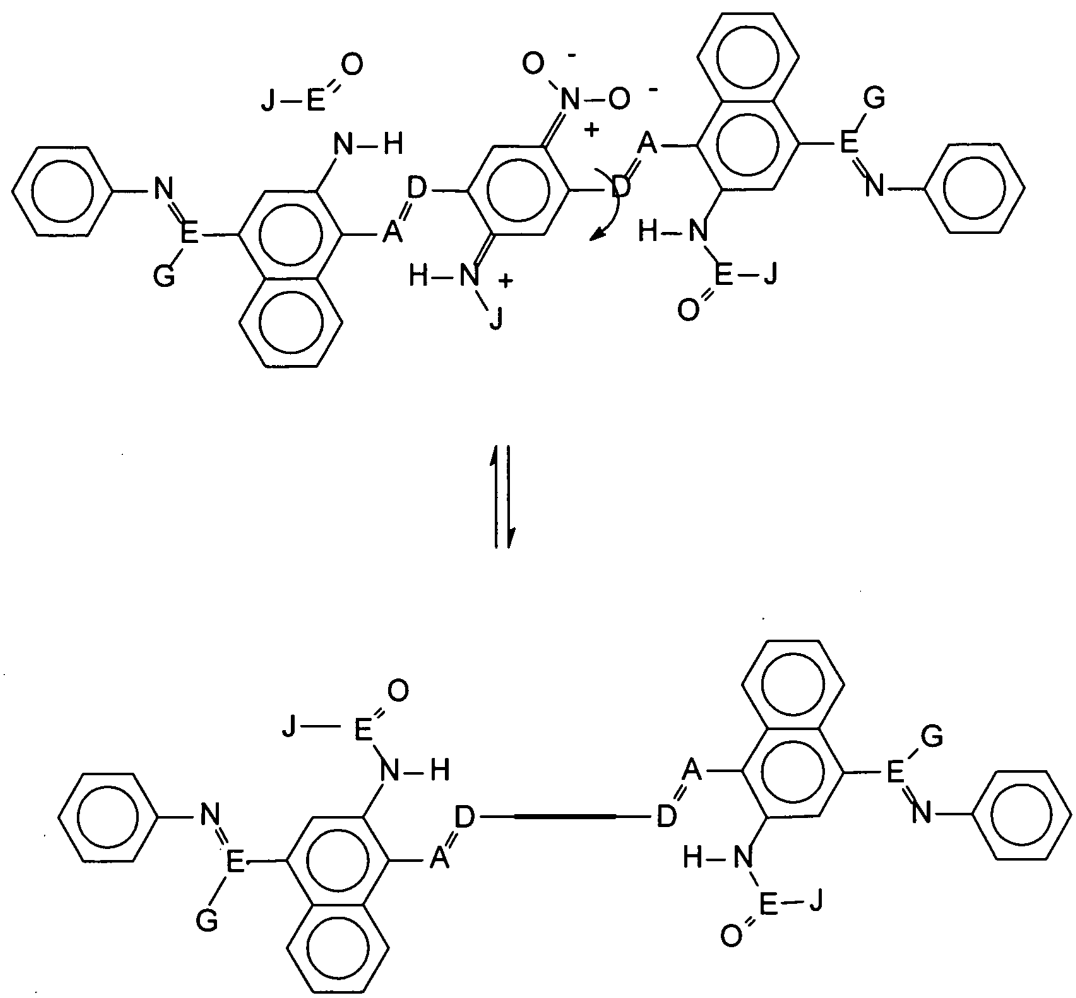
3. The molecular switch of Claim 2 wherein said molecular system comprises at least one stator portion and at least one rotor portion, wherein said rotor rotates from a first state to a second state with an applied electric field, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap.

4. The molecular switch of Claim 3 wherein said molecular system comprises:



where the vertical dashed lines represent electrodes to which said molecule is electrically attached.

5. The molecular switch of Claim 3 wherein said molecular system comprises:



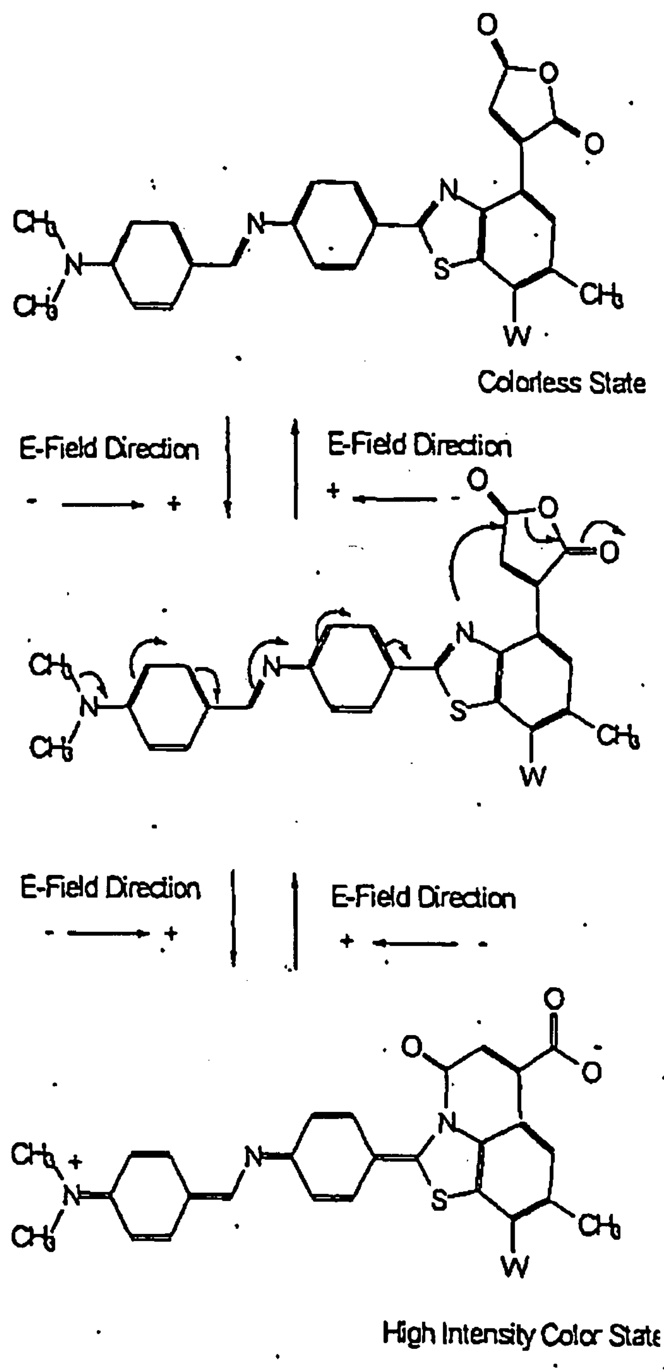
wherein the letters A, D, E, G, and J indicate sites where different chemical units can be utilized to adjust geometrical structure and optical properties of said molecular system and have generic designations as follows: A, D, E, G, and J are independently selected from the group consisting of heteroatoms, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom, and where in addition to the foregoing, the letters G and J are independently selected from the group consisting of hydrogen, F, Cl, Br, and I.

6. The molecular switch of Claim 1 wherein said electric field induced band gap occurs via a change of extended conjugation via chemical bonding change to change the band gap.

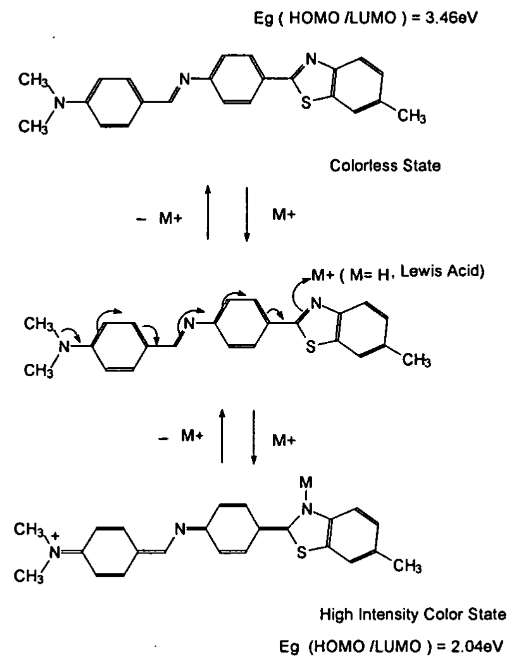
7. The molecular switch of Claim 6 wherein said electric field induced band gap change occurs via a change of extended conjugation via charge separation or recombination accompanied by increasing or decreasing band localization.

8. The molecular switch of Claim 7 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, thereby resulting in a relatively larger band gap state, with less π-delocalization, and recombination of charge in changing from said second state to said first state, thereby resulting in a relatively smaller band gap state, with greater π-delocalization.

9. The molecular switch of Claim 8 wherein said molecular system comprises:



10. The molecular switch of Claim 8 wherein said molecular system comprises:

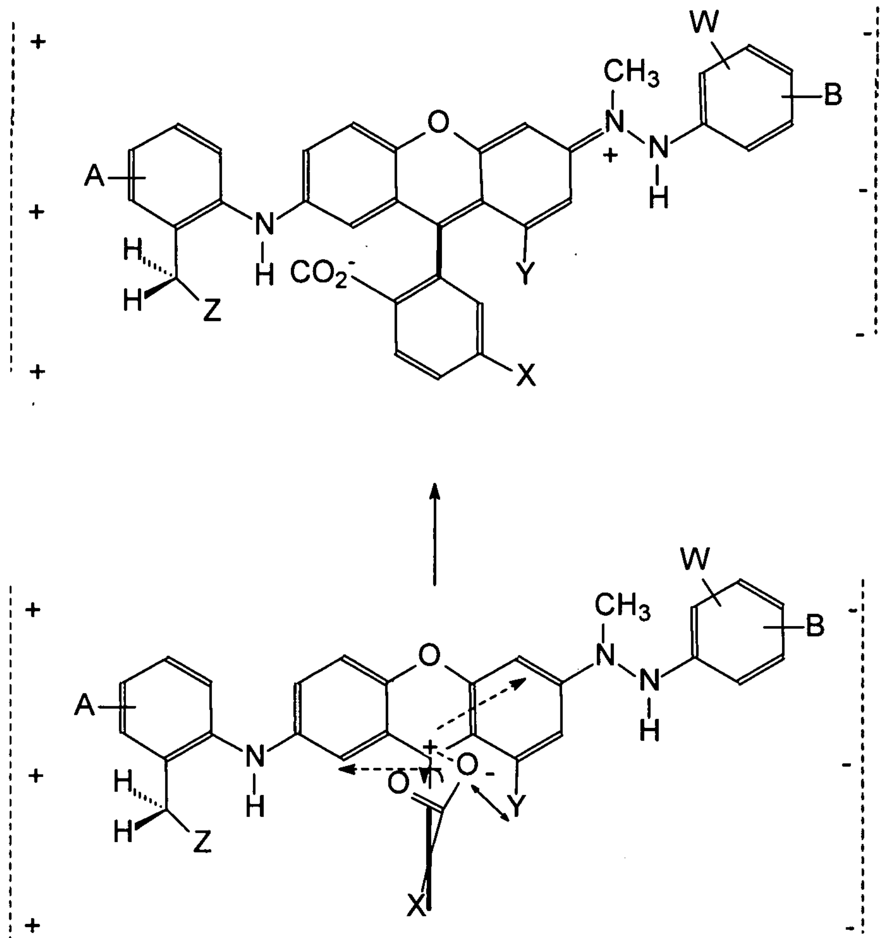


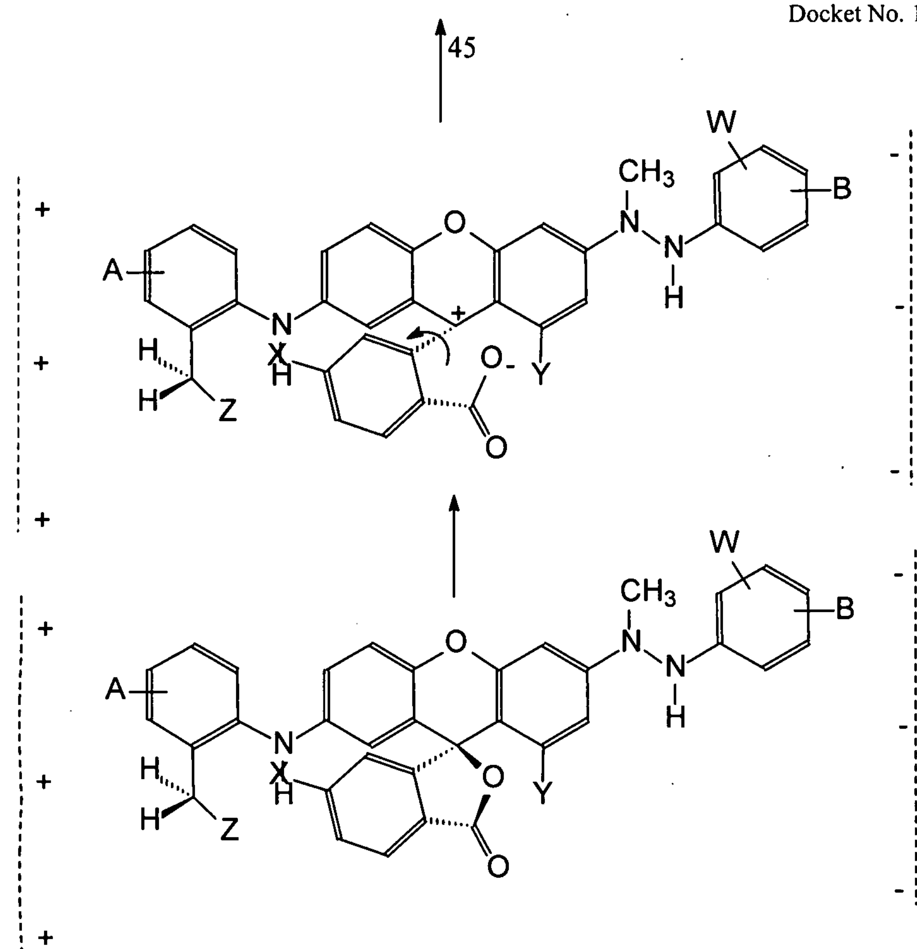
where M^+ represents metals, including transition metals, or their halogen complexes or H^+ or other type of Lewis acid(s).

11. The molecular switch of Claim 6 wherein said electric field induced band gap occurs via a change of extended conjugation via charge separation or recombination and π-bond breaking or formation.

12. The molecular switch of Claim 11 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively larger band gap state, and wherein in said second state, said extended conjugation is changed and separated positive and negative charges are created within said molecular system, resulting in a relatively smaller band gap state.

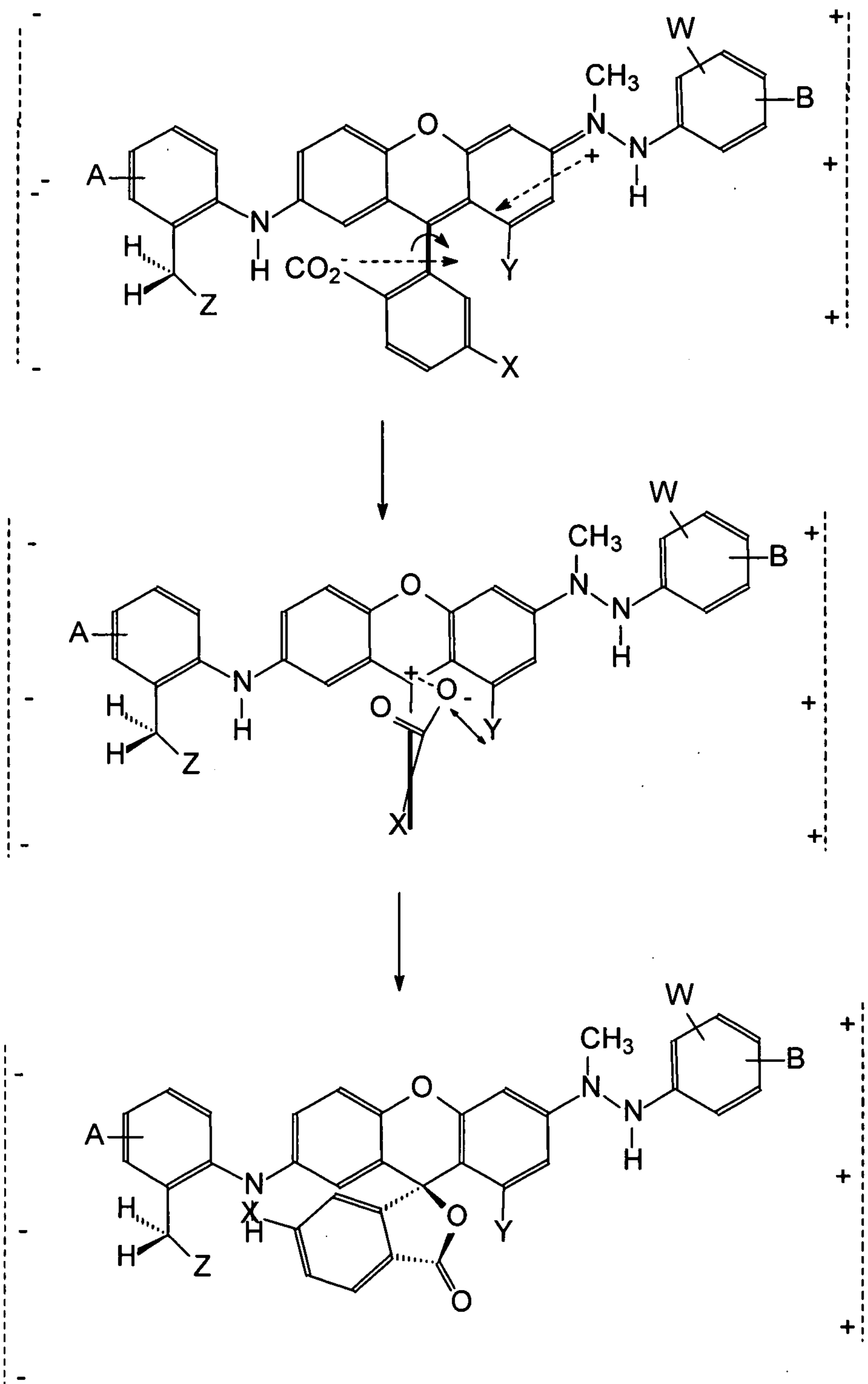
13. The molecular switch of Claim 12 wherein said molecular system comprises:





wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the vertical dashed lines represent electrodes with which said molecular system is electrically associated.

14. The molecular switch of Claim 12 wherein said molecular system comprises:

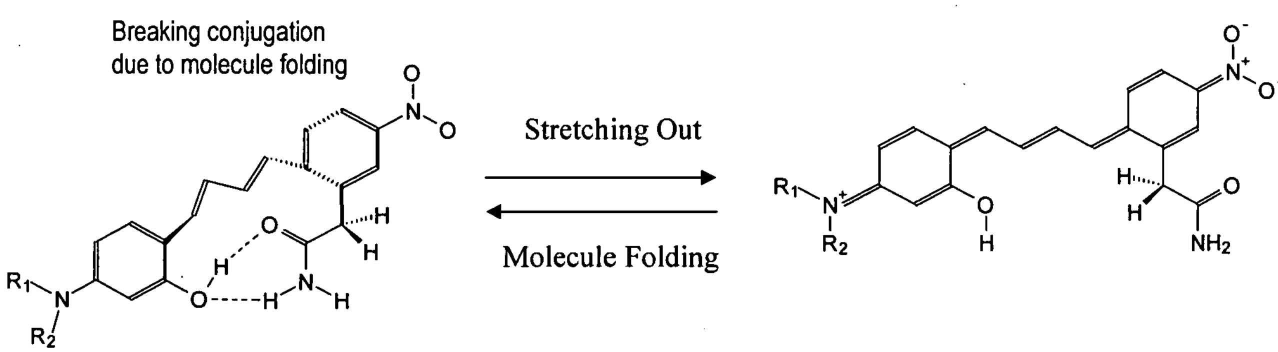


wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the vertical dashed lines represent electrodes with which said molecular system is electrically associated.

15. The molecular switch of Claim 1 wherein said electric field induced band gap change occurs via molecular folding or stretching.

16. The molecular switch of Claim 15 wherein said molecular system comprises three portions, a first portion and a third portion, each bonded to a second, central portion, wherein a change from a first state to a second state occurs with an applied electric field, said change involving a folding or stretching about or of said second portion, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap state, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap.

17. The molecular switch of Claim 16 wherein said molecular system comprises:



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom.

18. The molecular switch of Claim 1 comprising a crossed-wire device comprising a pair of crossed wires that form a junction where one wire crosses another at an angle other than zero

degrees and at least one connector species connecting said pair of crossed wires in said junction, said junction having a functional dimension in nanometers, wherein said at least one connector species comprises said molecular system.

19. The molecular switch of Claim 18 wherein said crossed-wire device is selected from the group consisting of memories, logic devices, multiplexers, demultiplexers, configurable interconnects for integrated circuits, field-programmable gate arrays (FGPAs), cross-bar switches, and communication devices.

20. The molecular switch of Claim 1 wherein said molecular system is sandwiched between a pair of electrodes and connected thereto by linking moieties.

21. A method of electrically switching between two different states in an electric field activated molecular switch comprising a crossed-wire device comprising at least one pair of crossed wires that form a junction where one wire crosses another at an angle other than zero degrees and at least one connector species connecting the pair of crossed wires in the junction, wherein the junction has a functional dimension in nanometers and wherein the connector species comprises a molecular system that has an electric field induced non-redox type of band gap change resulting from an intramolecular change in conjugation as p,π-electrons of the molecular system, through its highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), are alternately localized and delocalized over the entire molecular system by the electric field, wherein said electric field induced band gap change occurs via one of the following mechanisms:

(1) molecular conformation change or an isomerization;

(2) change of extended conjugation via chemical bonding change to change the band gap; or

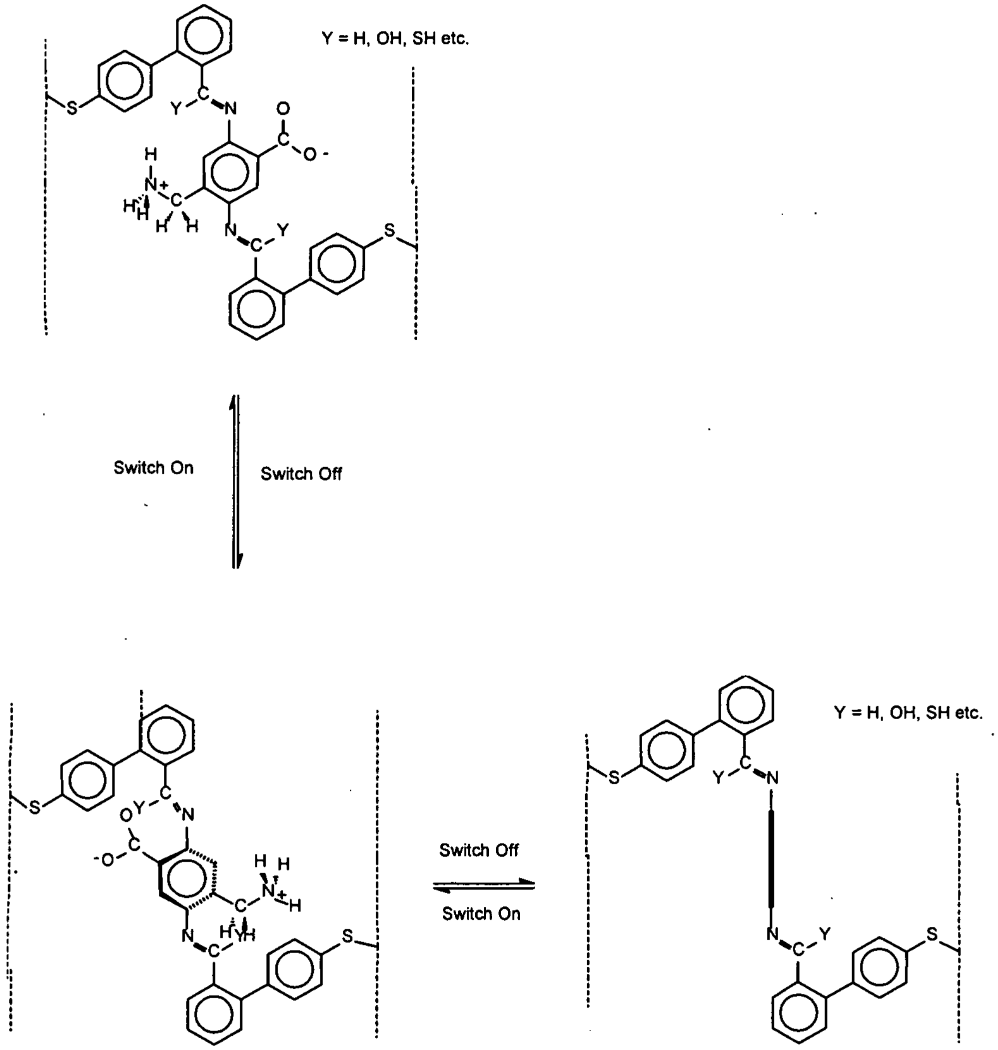
(3) molecular folding or stretching,

said method comprising applying a voltage to a pair of wires to cause a change in the state of said molecular system at said junction thereof.

22. The method of Claim 21 wherein said electric field induced band gap change occurs via molecular conformation change or an isomerization.

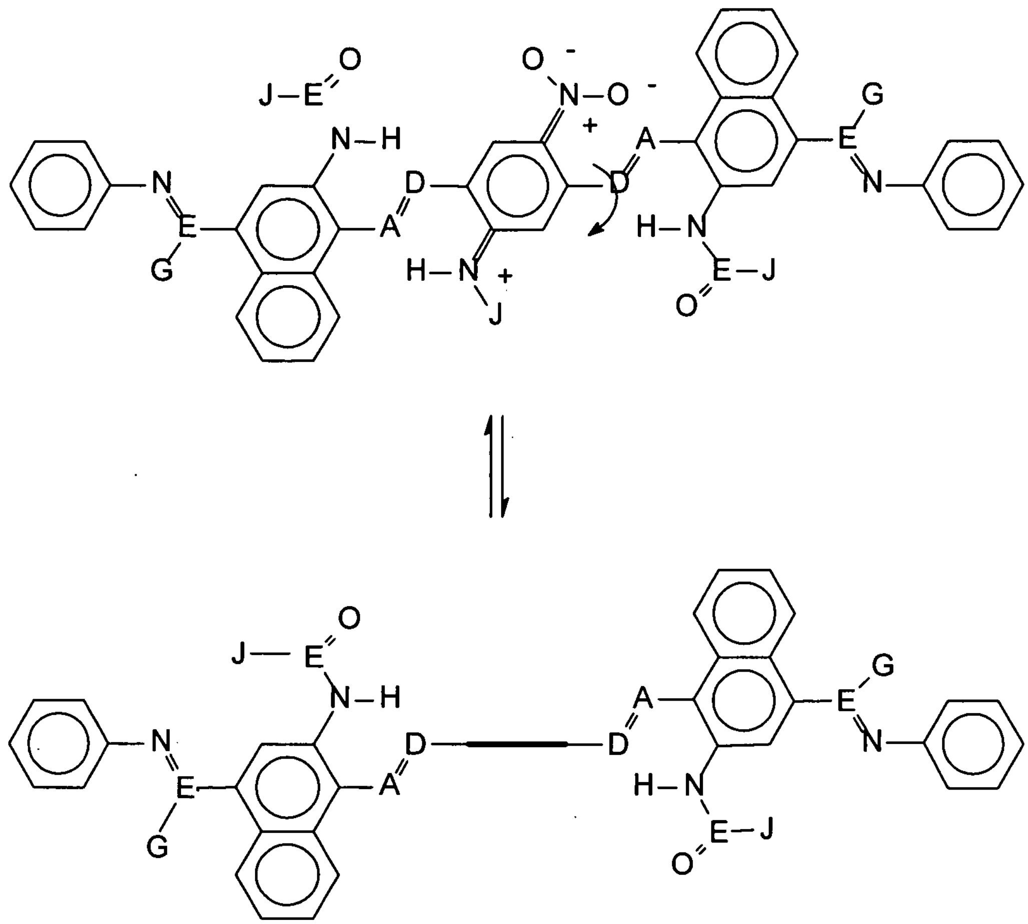
23. The method of Claim 22 wherein said molecular system comprises at least one stator portion and at least one rotor portion, wherein said rotor rotates from a first state to a second state with an applied electric field, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap.

24. The method of Claim 23 wherein said molecular system comprises:



where the vertical dashed lines represent electrodes to which said molecule is electrically attached.

25. The method of Claim 23 wherein said molecular system comprises:



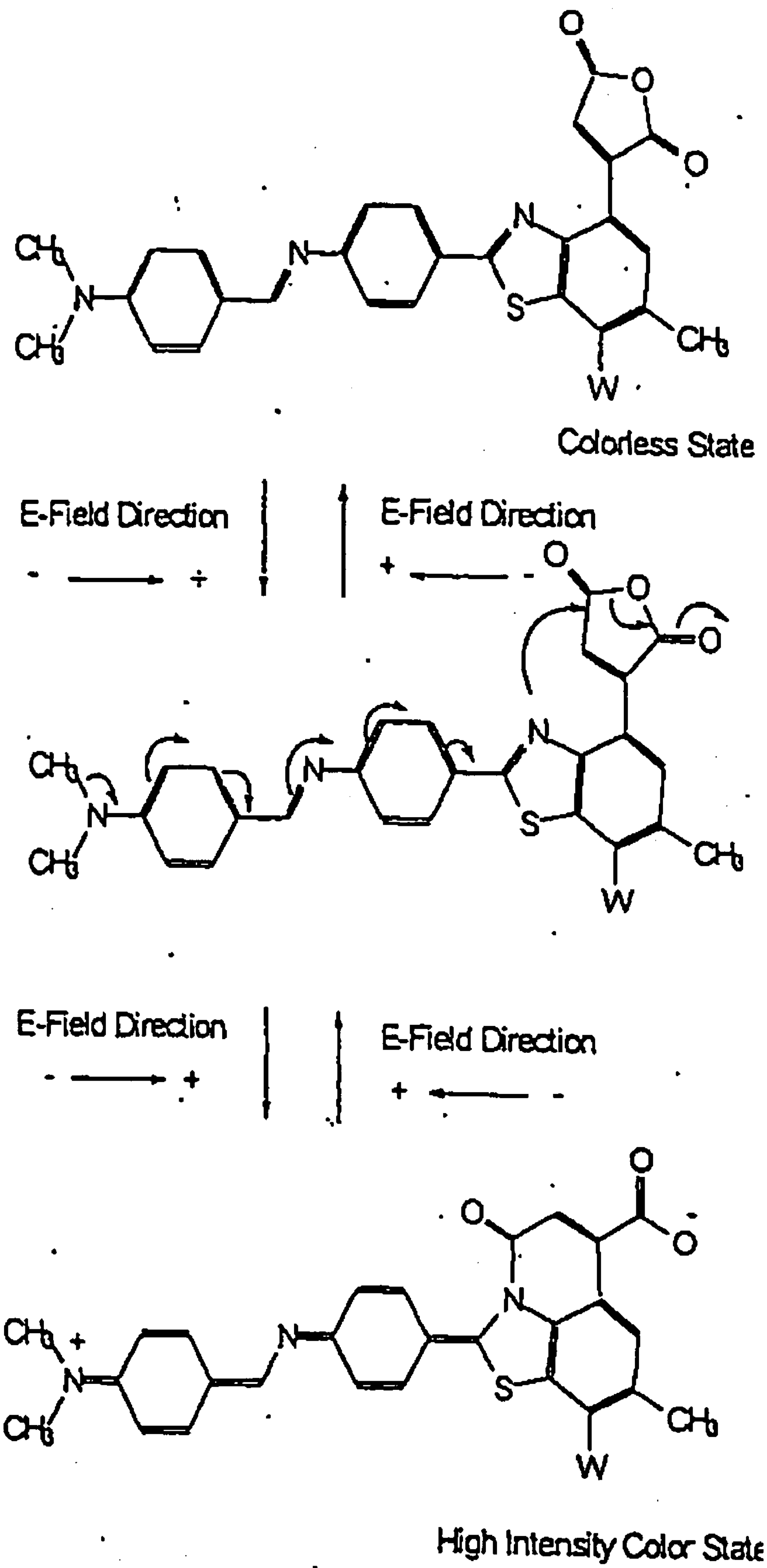
wherein the letters A, D, E, G, and J indicate sites where different chemical units can be utilized to adjust geometrical structure and optical properties of said molecular system and have generic designations as follows: A, D, E, G, and J are independently selected from the group consisting of heteroatoms, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom, and where in addition to the foregoing, the letters G and J are independently selected from the group consisting of hydrogen, F, Cl, Br, and I.

26. The method of Claim 21 wherein said electric field induced band gap occurs via a change of extended conjugation via chemical bonding change to change the band gap.

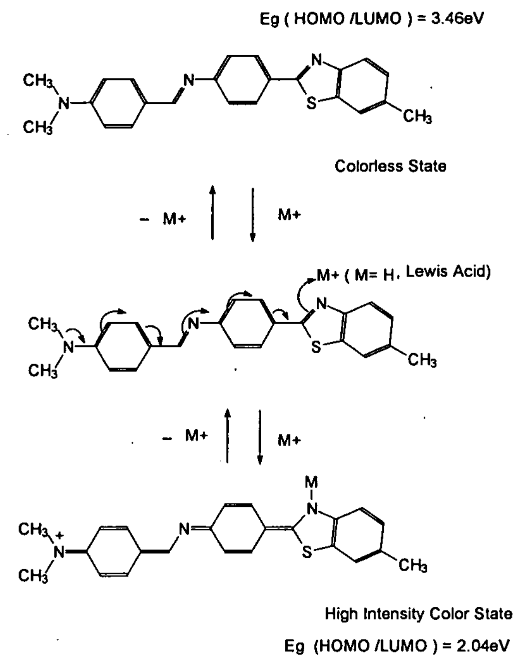
27. The method of Claim 26 wherein said electric field induced band gap change occurs via a change of extended conjugation via charge separation or recombination accompanied by increasing or decreasing band localization.

28. The method of Claim 27 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, thereby resulting in a relatively larger band gap state, with less π-delocalization, and recombination of charge in changing from said second state to said first state, thereby resulting in a relatively smaller band gap state, with greater π-delocalization.

29. The method of Claim 28 wherein said molecular system comprises:


Colorless State
E-Field Direction
E-Field Direction
High Intensity Color State

30. The method of Claim 28 wherein said molecular system comprises:

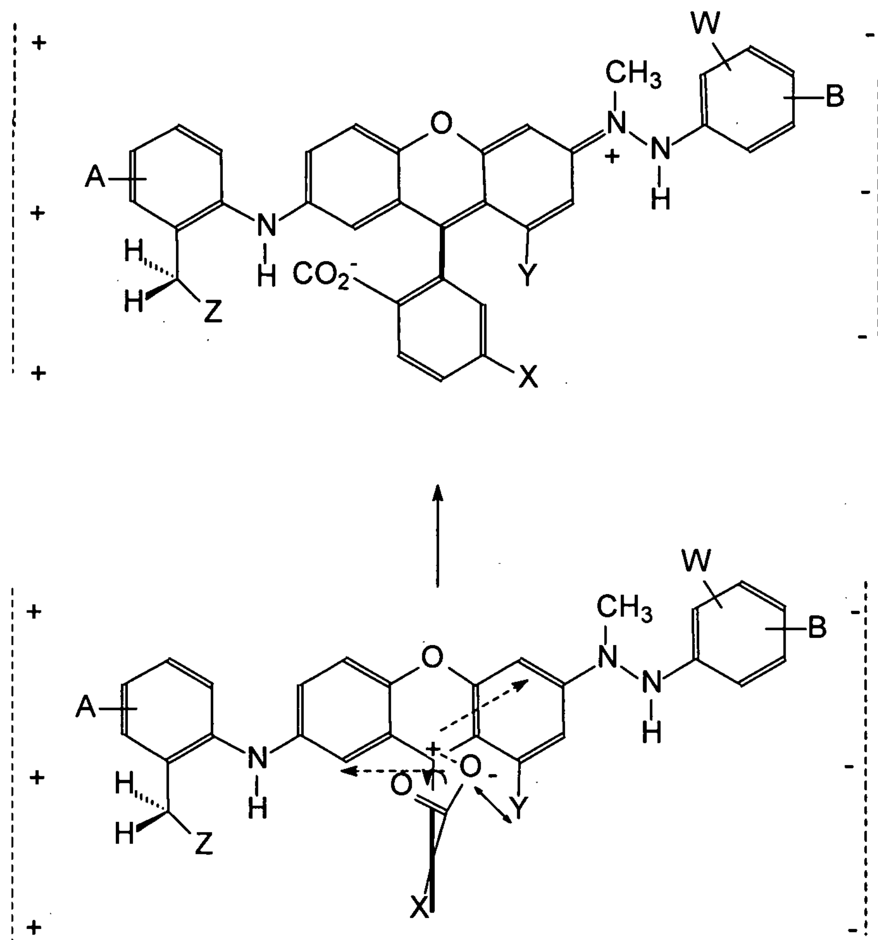


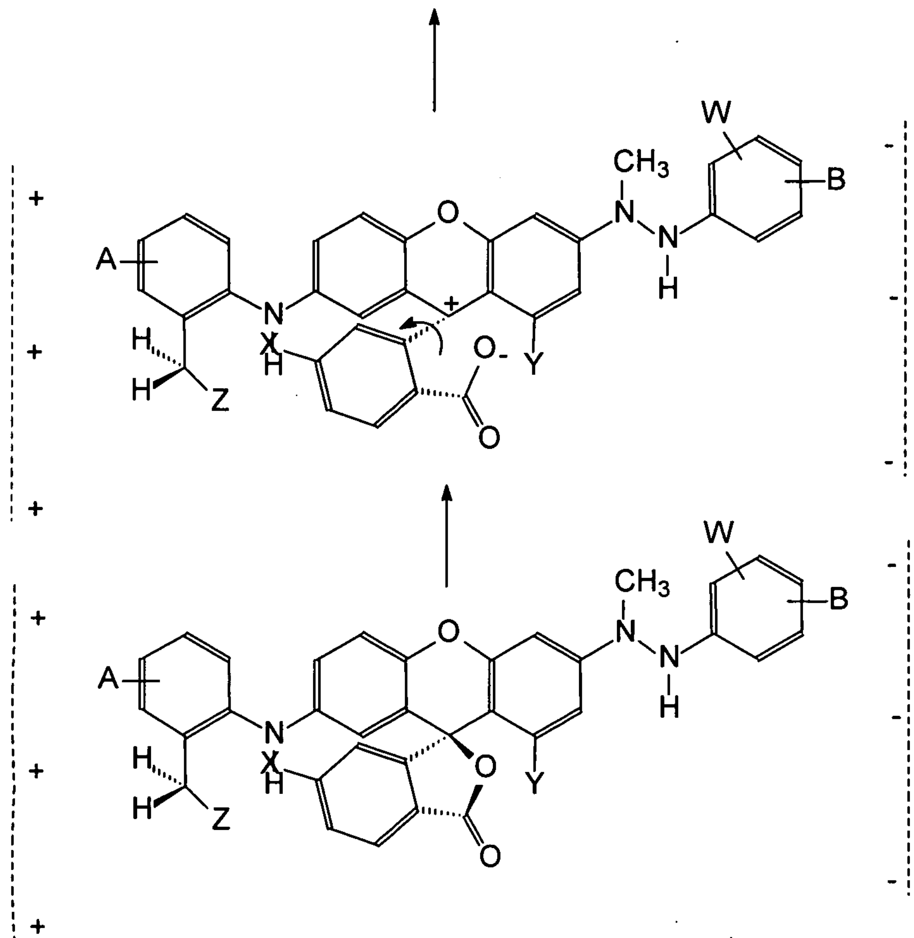
where M^+ represents metals, including transition metals, or their halogen complexes or H^+ or other type of Lewis acid(s).

31. The method of Claim 26 wherein said electric field induced band gap occurs via a change of extended conjugation via charge separation or recombination and π-bond breaking or formation.

32. The method of Claim 31 wherein said molecular system comprises two portions, wherein a change from a first state to a second state occurs with an applied electric field, said change involving charge separation in changing from said first state to said second state, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively larger band gap state, and wherein in said second state, said extended conjugation is changed and separated positive and negative charges are created within said molecular system, resulting in a relatively smaller band gap state.

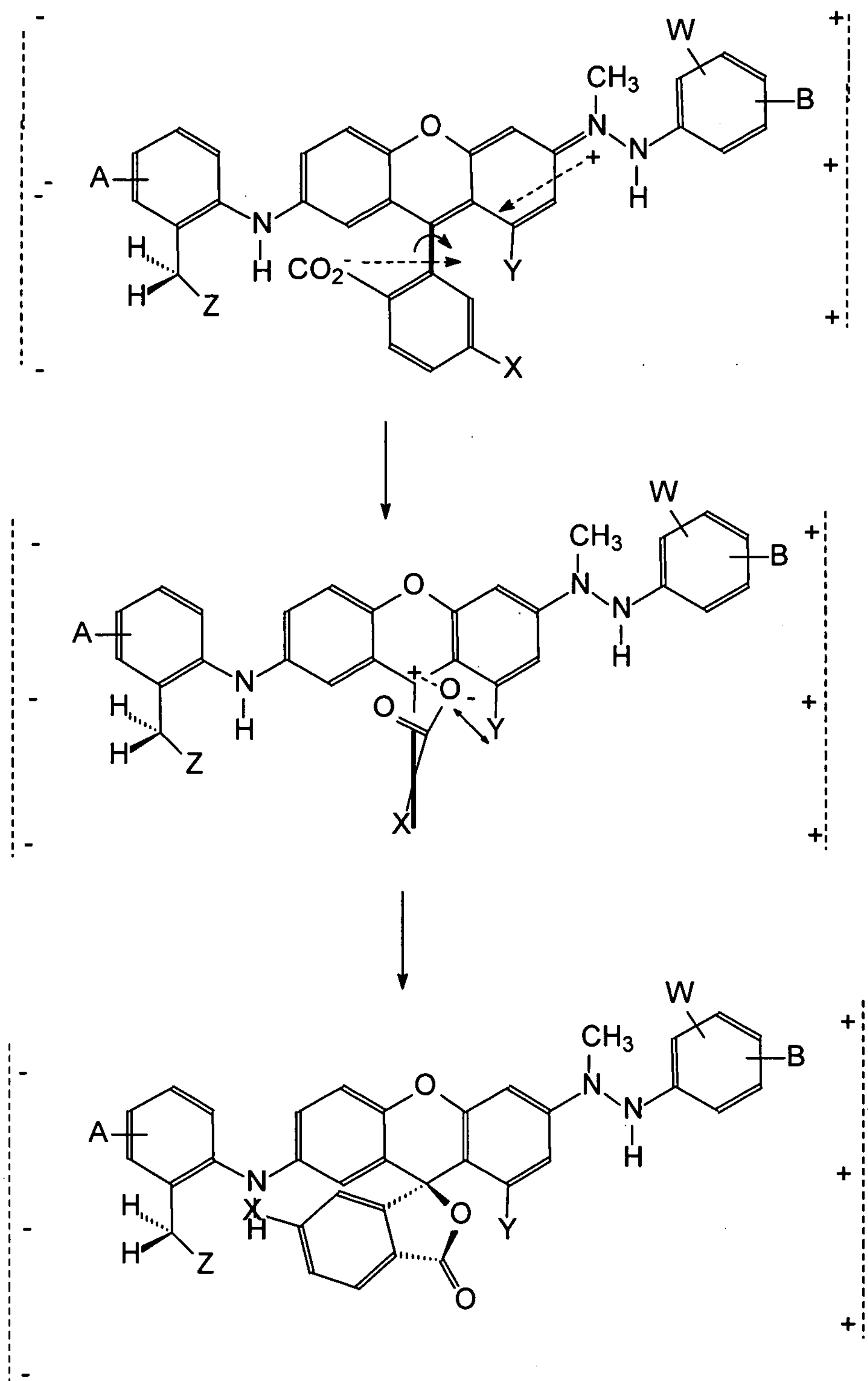
33. The method of Claim 32 wherein said molecular system comprises:





wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the vertical dashed lines represent electrodes with which said molecular system is electrically associated.

34. The method of Claim 32 wherein said molecular system comprises:



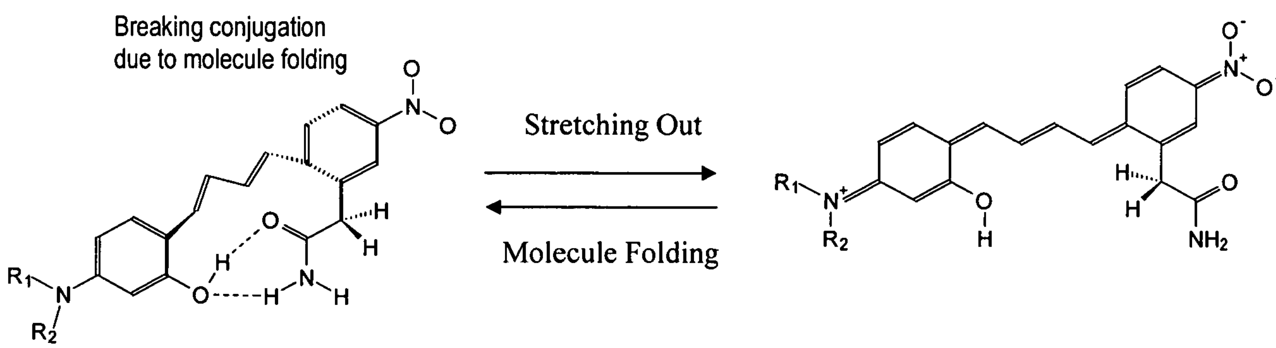
wherein A, B, W, X, Y, and Z are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom and the

vertical dashed lines represent electrodes with which said molecular system is electrically associated.

35. The method of Claim 21 wherein said electric field induced band gap change occurs via molecular folding or stretching.

36. The method of Claim 35 wherein said molecular system comprises three portions, a first portion and a third portion, each bonded to a second, central portion, wherein a change from a first state to a second state occurs with an applied electric field, said change involving a folding or stretching about or of said second portion, wherein in said first state, there is extended conjugation throughout said molecular system, resulting in a relatively smaller band gap state, and wherein in said second state, said extended conjugation is changed, resulting in a relatively larger band gap.

37. The method of Claim 36 wherein said molecular system comprises:



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, heteroatoms, functional groups with at least one said heteroatom, hydrocarbons (either saturated or unsaturated), and hydrocarbons with at least one said heteroatom.

38. The method of Claim 21 comprising a crossed-wire device comprising a pair of crossed wires that form a junction where one wire crosses another at an angle other than zero degrees and at least one connector species connecting said pair of crossed wires in said junction, said junction having a functional dimension in nanometers, wherein said at least one connector species comprises said molecular system.

39. The method of Claim 38 wherein said crossed-wire device is selected from the group consisting of memories, logic devices, multiplexers, demultiplexers, configurable interconnects for integrated circuits, field-programmable gate arrays (FGPAs), cross-bar switches, and communication devices.

40. The method of Claim 1 wherein said molecular system is sandwiched between a pair of electrodes and connected thereto by linking moieties.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.